ENVIRONMENTAL ASSESSMENT
(Final)

MANAGING DAMAGE CAUSED BY PREDATORS IN OKLAHOMA

Prepared by

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

In cooperation with

OKLAHOMA DEPARTMENT OF AGRICULTURE FOOD AND FORESTRY

October 2017

TABLE OF CONTENTS

ACRONYMS .... *iii*

CHAPTER 1: NEED FOR ACTION AND SCOPE OF ANALYSIS

1.1 INTRODUCTION 1
1.2 NEED FOR ACTION 2
1.3 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT 15
1.4 RELATIONSHIP OF THIS EA TO OTHER DOCUMENTS 17
1.5 AUTHORITY OF STATE AND FEDERAL AGENCIES 19
1.6 COMPLIANCE WITH LAWS AND STATUTES 20
1.7 DECISIONS TO BE MADE 24

CHAPTER 2: AFFECTED ENVIRONMENT AND ISSUES

2.1 AFFECTED ENVIRONMENT 24
2.2 ISSUES ASSOCIATED WITH PREDATOR DAMAGE MANAGEMENT ACTIVITIES 26
2.3 ISSUES CONSIDERED BUT NOT ANALYZED FOR EACH ALTERNATIVE 29

CHAPTER 3: ALTERNATIVES

3.1 DESCRIPTION OF THE ALTERNATIVES 44
3.2 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL 52
3.3 STANDARD OPERATING PROCEDURES FOR PREDATOR DAMAGE MANAGEMENT 61
3.4 ADDITIONAL STANDARD OPERATING PROCEDURES SPECIFIC TO THE ISSUES 62

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

4.1 EVALUATION OF SIGNIFICANCE 66
4.2 ENVIRONMENTAL CONSEQUENCES FOR ISSUES ANALYZED IN DETAIL 67
4.3 CUMULATIVE IMPACTS OF ALTERNATIVE 1 BY ISSUE 130

CHAPTER 5: RESPONSES TO PUBLIC COMMENTS

5.1 SUMMARY OF PUBLIC COMMENTS AND WS' RESPONSES TO THE COMMENTS 135

CHAPTER 6: LIST OF PREPARERS AND AGENCIES CONSULTED

6.1 LIST OF PREPARERS 138
6.2 LIST OF AGENCIES CONSULTED 138

LIST OF APPENDICES:

APPENDIX A – LITERATURE CITED A-1
APPENDIX B – METHODS AVAILABLE FOR RESOLVING OR PREVENTING PREDATOR DAMAGE B-1
APPENDIX C – WS' RESPONSE TO EVALUATION OF STUDIES BY TREVES ET AL. (2016) C-1

ACRONYMS

AMDUCA	Animal Medicinal Drug Use Clarification Act
APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
BLM	Bureau of Land Management
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLIR	Forward Looking Infrared
FPL	Feline Panleukopenia
FR	Federal Register
FY	Fiscal Year
IV	Intravenous
IC	Intracardiac
MOU	Memorandum of Understanding
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NWRC	National Wildlife Research Center
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
ODWC	Oklahoma Department of Wildlife Conservation
OS	Oklahoma Statutes
PEP	Post - Exposure Prophylaxis
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WS	Wildlife Services

CHAPTER 1: NEED FOR ACTION AND SCOPE OF ANALYSIS

1.1 INTRODUCTION

Wildlife is an important public resource greatly valued by people. Wildlife can have either positive or negative values depending on the perspectives and circumstances of individual people. In general, people regard wildlife as providing economic, recreational, and aesthetic benefits. Knowing that wildlife exists in the natural environment provides a positive benefit to many people. However, the behavior of animals may result in damage to agricultural resources, natural resources, property, and threaten human safety. Animals have no intent to do harm. They utilize habitats (*e.g.*, feed, shelter, reproduce) where they can find a niche. If their activities result in lost value of resources or threaten human safety, people often characterize this as damage. When damage exceeds or threatens to exceed an economic threshold and/or pose a threat to human safety, people often seek assistance. The threshold triggering a request for assistance is often unique to the individual person requesting assistance and many factors can influence when people request assistance (*e.g.*, economic, social, aesthetics). Therefore, what constitutes damage is often unique to the individual person. What one individual person considers damage, another person may not consider as damage. However, the use of the term "*damage*" is consistently used to describe situations where the individual person has determined the losses associated with an animal or animals is actual damage requiring assistance (*i.e.*, has reached an individual threshold). Many people define the term "*damage*" as economic losses to resources or threats to human safety; however, "*damage*" could also occur from a loss in the aesthetic value of property and other situations where the behavior of animals was no longer tolerable to an individual person. The threat of damage or loss of resources is often sufficient for people to initiate individual actions and the need for damage management could occur from specific threats to resources.

Native predatory wildlife performs a vital role in a healthy ecosystem; however, predatory animals can also cause damage or pose a threat to resources, including threats to people. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS)[1] program in Oklahoma continues to receive requests for assistance or anticipates receiving requests for assistance to resolve or prevent damage associated with badgers (*Taxidea taxus*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), feral/free-ranging cats (*Felis domesticus*), feral/free-ranging dogs (*Canis familiaris*), gray fox (*Urocyon cinereoargenteus*), raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), river otters (*Lutra canadensis*), striped skunk (*Mephitis mephitis*), and Virginia opossum (*Didelphis virginiana*). In addition to those species, WS and the ODAFF could also receive requests for assistance to manage damage and threats of damage associated with black bears (*Ursus americanus*), hog-nosed skunks (*Conepatus leuconotus*), long-tailed weasels (*Mustela frenata*), mink (*Neovison vison*), mountain lions (*Puma concolor*), ringtails (*Bassariscus astutus*), spotted skunks (*Spilogale putorius*), and swift fox (*Vulpes velox*). However, requests for assistance associated with those species would occur infrequently and/or requests would involve a small number of individuals from a specific species. This document will collectively refer to those mammal species using the term "*predators*".

Individual damage management projects conducted by the WS program could be categorically excluded from further analysis under the National Environmental Policy Act (NEPA), in accordance with APHIS implementing regulations for the NEPA (7 CFR 372.5(c), 60 FR 6000-6003). The purpose of this Environmental Assessment (EA) is to evaluate cumulatively the individual projects that WS could conduct to manage damage and threats to agricultural resources, property, natural resources, and threats to people caused by predators. This EA will assist in determining if the proposed cumulative management of predator damage could have a significant impact on the environment based on previous activities

[1]The WS program is authorized to protect agriculture and other resources from damage caused by animals through the Act of March 2, 1931 (46 Stat. 1468; 7 USC 8351-8352) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 8353).

conducted by WS and based on the anticipation of conducting additional efforts to manage damage caused by those species. Because the goal of WS would be to conduct a coordinated program to alleviate predator damage in accordance with plans, goals, and objectives developed to reduce damage, and because the program's goals and directives[2] would be to provide assistance when requested, within the constraints of available funding and workforce, it is conceivable that additional damage management efforts could occur. Thus, this EA anticipates those additional efforts and the analyses would apply to actions that may occur in any locale and at any time within Oklahoma as part of a coordinated program.

This EA analyzes the potential effects of managing damage caused by predators when requested, as coordinated between WS, the Oklahoma Department of Agriculture, Food and Forestry (ODAFF), and the Oklahoma Department of Wildlife Conservation (ODWC). WS, in cooperation with the ODAFF, is preparing this EA to: 1) facilitate planning, 2) promote interagency coordination, 3) streamline program management, 4) clearly communicate to the public the analysis of individual and cumulative impacts of proposed activities, and 5) evaluate and determine if there would be any potentially significant or cumulative effects from the alternative approaches developed to meet the need for action. The analyses contained in this EA are based on information derived from WS' Management Information System, published documents (see Appendix A), interagency consultations, and public involvement.

The EA evaluates the need for action to manage damage associated with predators in the State, the potential issues associated with managing damage, and the environmental consequences of conducting different alternatives to meet the need for action while addressing the identified issues. WS, in cooperation with the ODAFF, initially developed the issues and alternatives associated with managing damage caused by predators in consultation with the ODWC. The ODWC has regulatory authority to manage populations of wild predator species in the State. To assist with identifying additional issues and alternatives to managing damage associated with predators in Oklahoma, WS and the ODAFF will make this EA available to the public for review and comment prior to the issuance of a Decision[3].

WS previously developed an EA that addressed WS' activities to manage damage associated with predators in the State. The previous EA identified the issues associated with managing damage associated with predators and analyzed alternative approaches to meet the specific need identified in the EA while addressing the identified issues. Changes in the need for action and the affected environment have prompted WS to initiate this new analysis to address predator damage in the State. In addition, this EA will: (1) assist in determining if the proposed management of damage associated with predators could have a significant impact on the environment for both people and other organisms, (2) analyze several alternatives to address the need for action and the identified issues, (3) coordinate efforts between WS, the ODAFF, the ODWC, and other entities, (4) inform the public, and (5) document the environmental consequences of the alternatives to comply with the NEPA. Since this new EA will re-evaluate those activities conducted under the previous EA to address new information, the analyses and the outcome of the Decision issued based on the analyses in this EA will supersede the previous EA that addressed the need to manage predator damage.

1.2 NEED FOR ACTION

Wildlife damage management is the alleviation of damage or other problems caused by or related to the behavior of wildlife and can be an integral component of wildlife management (Berryman 1991,

---

[2]At the time of preparation, WS' Directives occurred at the following web address: http://www.aphis.usda.gov/wildlife_damage/ws_directives.shtml.

[3]After the development of the EA by WS and the ODAFF and after public involvement with identifying new issues and alternatives, WS will issue a Decision. Based on the analyses in the EA after public involvement, WS will make a decision to publish a Notice of Intent to prepare an Environmental Impact Statement or WS will issue a Finding of No Significant Impact notice to the public in accordance to the NEPA and the Council of Environmental Quality regulations.

Reidinger and Miller 2013, The Wildlife Society 2015) and the North American Model of Wildlife Conservation (Geist 2006, Organ et al. 2010). Resolving damage caused by predators requires consideration of both sociological and biological carrying capacities. The wildlife acceptance capacity, or cultural carrying capacity, is the limit of human tolerance for wildlife or the maximum number of a given species that can coexist compatibly with local human populations. Biological carrying capacity is the land or habitat's ability to support healthy populations of wildlife without degradation to the species' health or their environment during an extended period of time (Decker and Purdy 1988).

Those phenomena are especially important because they define the sensitivity of a person or community to a wildlife species. For any given damage situation, there are varying thresholds of tolerance exhibited by those people directly and indirectly affected by the species and any associated damage. This damage threshold determines the wildlife acceptance capacity. While the biological carrying capacity of the habitat may support higher populations of animals, in many cases the acceptance capacity is lower or already met. Once the acceptance capacity is met or exceeded, people begin to implement population or damage management to alleviate damage or address threats to human health and safety. Therefore, the acceptance capacity helps define the range of animal population levels and associated damages acceptable to individuals or groups (Decker and Brown 2001). A number of factors, including regulated hunting and trapping, influence the impacts of wildlife-related damages. The International Association of Fish and Wildlife Agencies (2005) estimated that without regulated hunting and trapping, wildlife damage to livestock and poultry would increase 221% to an estimated total of $571 million.

The impacts of wildlife damage within the United States affect a variety of human interests, including the safety of people, crops and livestock, natural resources, and personal property (Conover et al. 1995). When questioned about the negative impacts of wildlife, 80% of ranchers and farmers reported some type of wildlife damage and 53% said the losses exceeded their tolerance limits (Conover 1998). Wywialowski (1994) reported on wildlife-caused losses within the Northern Great Plains of the United States and carnivore predation to livestock-poultry accounted for 17% of the reported losses. The threat of damage or loss of resources is often sufficient for people to initiate individual actions and the need for damage management can occur from specific threats to resources. The need for action to manage damage and threats associated with predators in Oklahoma arises from requests for assistance[4] received by the WS program.

Table 1.1 shows the number of technical assistance projects conducted by the WS program in Oklahoma from federal fiscal year[5] (FY) 2009 through FY 2016. Between FY 2009 and FY 2014, the WS program conducted 4,819 projects in Oklahoma associated with damage caused by those predators addressed in Table 1, which represents nearly 625 projects per year. The majority of technical assistance projects were associated with coyotes, striped skunks, and raccoons. Technical assistance provides information and recommendations on activities to alleviate predator damage that the requester could conduct without WS' direct involvement in managing or preventing the damage. This EA discusses technical assistance activities further in Section 3.1. Table 1.1 does not include direct operational assistance projects conducted by WS where a person or persons requested WS' assistance through the direct application of methods.

[4]The WS program would only conduct predator damage management after receiving a request for assistance. Before initiating damage management activities, WS and the cooperating entity would sign a Memorandum of Understanding, Work Initiation Document, Annual Work Plan, or other comparable document that would list all the methods the property owner or manager would allow WS' personnel to use on property they owned and/or managed.

[5]The federal fiscal year begins on October 1 and ends on September 30 the following year.

Table 1.1 – Technical assistance projects conducted by WS from FY 2009 through FY 2016[†]

Species	Projects	Species	Projects
Badger	70	Mountain Lion	105
Black Bear	14	Raccoons	318
Bobcat	183	Red Fox	31
Coyote	3,273	Ringtail	0
Feral/Free-ranging Cat	19	River Otter	76
Feral/Free-ranging Dog	86	Spotted Skunk	0
Gray Fox	31	Striped Skunk	551
Hog-nosed Skunk	2	Swift Fox	0
Long-tailed Weasel	2	Virginia Opossum	57
Mink	1	**TOTAL**	**4,819**

[†]Table 1.1 does not include direct operational assistance projects conducted by WS where a person or persons requested WS' assistance through the direct application of methods.

Table 1.2 lists those predator species addressed in this EA and the resource types that those predator species can cause damage to in Oklahoma. Many of the predator species can cause damage to or pose threats to a variety of resources. In Oklahoma, most requests for assistance received by WS are associated with those predator species causing damage or posing threats of damage to agricultural resources. All of the species addressed in this EA can cause damage to property, including posing strike risks at airports and airbases or posing as attractants for other species that are strike risks.

Table 1.2 – Predator species that WS could address and the resource type damaged by those species

Species	Resource[a]				Species	Resource			
	A	N	P	H		A	N	P	H
Badger	X	X	X	X	Mountain Lion	X	X	X	X
Black Bear	X	X	X	X	Raccoons	X	X	X	X
Bobcat	X	X	X	X	Red Fox	X	X	X	X
Coyote	X	X	X	X	Ringtails			X	X
Feral Cat	X	X	X	X	River Otter	X	X	X	X
Feral Dog	X	X	X	X	Spotted Skunk	X	X	X	X
Gray Fox	X	X	X	X	Striped Skunk	X	X	X	X
Hog-nosed Skunk	X	X	X	X	Swift Fox	X	X	X	X
Long-tailed Weasel	X	X	X	X	Virginia Opossum	X	X	X	X
Mink	X	X	X	X					

[a]A=Agriculture, N =Natural Resources, P=Property, H=Human Safety

More specific information regarding predator damage to those main categories are discussed in the following subsections of the EA.

Need for Predator Damage Management to Alleviate Damage to Agricultural Resources

Bobcats, coyotes, feral/free-ranging cats, feral/free-ranging dogs, fox, skunks, weasels, mink, raccoons, ringtails, and opossum can cause losses or injury to crops, livestock (*e.g*., sheep, goats, cattle, pigs, horses), and poultry (*e.g*., chickens, turkeys, geese, ducks) through consumption or predation. During 2001, crop and livestock losses from wildlife in the United States totaled $944 million, with field crop losses totaling $619 million, livestock and poultry losses totaling $178 million, and losses of vegetables, fruits, and nuts totaling $146 million. Those losses include destruction of or damage to crops in the field and death or injury to livestock. In 2001, the National Agricultural Statistics Service (NASS) reported that raccoons were responsible for 6%, 3%, and 6% of the total damage to field crops; livestock and poultry; and vegetables, fruits, and nuts, respectively, in the United States (NASS 2002). In Oklahoma, the market value of agricultural products sold during 2007 was over $5.8 billion, with the value of livestock, poultry, and their products accounting for nearly 80% of the market value (NASS 2014).

Predators are responsible for preying upon a wide variety of livestock, including cattle, sheep, goats, swine, exotic pen-raised game, other hoofed-stock, and poultry. For example, cattle and calves are vulnerable to predation, especially during calving (Bodenchuk et al. 2002). Sheep, goats, 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). Livestock losses due to predation can cause economic hardships to farmers and ranchers, and without effective ways to reduce predation rates, economic losses from predation can increase (Nass 1977, Howard and Shaw 1978, Nass 1980, Howard and Booth 1981, O'Gara et al. 1983, Bodenchuk et al. 2002). Not all producers suffer losses to predators; however, for those producers that do suffer livestock losses caused by predators, those losses can be economically burdensome (Baker et al. 2008).

Of the predators that kill livestock, coyotes are likely responsible for the highest percentage (Knowlton et al. 1999, Shelton 2004, NASS 2005, NASS 2006, NASS 2010, NASS 2011, APHIS Veterinary Services 2012, APHIS Veterinary Services 2015, APHIS Veterinary Services 2017). In a study of sheep predation on rangelands in Utah, coyotes accounted for 67% of depredated lambs followed by cougar predation at 31% (Palmer et al. 2010). Palmer et al. (2010) replicated a study from the 1970s to determine how predation rates on sheep may have changed over time. Overall, fewer lambs were lost to all causes than during the 1970s (5.8% compared with 9.5%, respectively); however, the proportion of losses to predators did not change substantially. Predators were responsible for 87% of the total lamb losses compared with 83% in the 1970s (Palmer et al. 2010). Coyotes accounted for 93% of all predator-killed lambs and ewes on nine sheep bands in shed lambing operations in southern Idaho and 25% of those sheep killed by coyotes were not fed upon (Nass 1977). DeLorenzo and Howard (1977) found that coyotes were the predominant predator on sheep during a study in Colorado and of those lambs killed by coyotes in the study, more than 43% were not fed upon. Similarly, coyotes were also the primary predator on sheep during a Wyoming study and essentially the only predator in winter (Tigner and Larson 1977).

A positive correlation between predator concentrations and livestock losses due to predation often exists (Shelton and Klindt 1974, Pearson and Caroline 1981, Nunley 1995). When predator concentrations increase, predation loss can be a major factor in cattle, sheep, and goat production. In 2010, the NASS (2011) reported cattle and calf losses from animal predation totaled 219,900 head in the United States according to livestock producers. Animal predation represented 5.5% of the total cattle and calf losses reported by livestock producers in 2010 totaling $98.5 million in economic losses. Cattle producers identified coyotes as the primary predator of livestock with 53.1% of cattle and calf losses attributed to coyotes in 2010. Producers also attributed livestock losses to bobcats, mountain lions, and dogs. In the United States, Pimentel et al. (2005) estimated that feral dogs caused $620 million in losses annually. Bergman et al. (2009) provides a summary of the feral dog damage in the United States. Young et al. (2011) stated, "*In human-populated landscapes, dogs…are of the most abundant terrestrial carnivore*" and "*The impacts of dog predation in some cases may be more severe than those of wild predators*".

Producers spent nearly $188.5 million dollars on non-lethal methods to reduce cattle and calf losses from predation by animals in 2010 (NASS 2011). The primary non-lethal method employed by livestock producers was the use of guard animals. Of those cattle producers who used non-lethal methods, 36.9% of producers reported using guard animals. Producers also reported using exclusion fencing, frequent checking, and culling as additional employed methods for reducing predation (NASS 2011).

Livestock production in Oklahoma contributes substantially to the State's economy. In January of 2013, the livestock inventory in Oklahoma was estimated 4.2 million cattle, 75,000 sheep, and 112,100 goats

(NASS 2014). In December 2012, there were an estimated 2.3 million domestic swine in the State (NASS 2014). People in Oklahoma also raise poultry, sheep, horses, and other livestock (NASS 2014). In 2007, the total market value of livestock and poultry products sold in the State was estimated to exceed $4.6 billion (NASS 2014). The value of cattle and calf sales in the State during 2007 were estimated to exceed $3 billion, while the sale of swine was estimated to exceed $555 million (NASS 2014). Sheep and goat sales exceeded $12 million during 2007, while horses, ponies, mules, burros, and donkey sales exceeded $36 million (NASS 2014).

Predation on livestock is well documented, with coyotes the primary predator to cattle (NASS 2006, NASS 2011, APHIS Veterinary Services 2012, APHIS Veterinary Services 2017) and sheep (Schaefer et al. 1981, O'Gara et al. 1983, Nass et al. 1984, Neale et al. 1998, NASS 2010, Sacks and Neale 2007, Palmer et al. 2010, APHIS Veterinary Services 2015). The annual loss of all classes of livestock to predation varies by year and by location (Baker et al. 2008). For example, coyotes were responsible for 45% of the calf predation in Oklahoma during 2005 (NASS 2006). However, in 2010, coyotes were responsible for 53% of the calf predation in Oklahoma (NASS 2011).

Cattle and calf predation losses due to predators in Oklahoma was valued at over $5.6 million in 2005 (NASS 2006) and nearly $6.9 million in 2010 (NASS 2011). Of the animal predators identified as causing losses to cattle in 2010, coyotes were responsible for about 36% of the losses, while people attributed 17% of the losses to unknown predators (NASS 2011). Of the calf loss, coyotes, mountain lions/bobcats, and dogs were responsible for 53%, 7.1%, and 14% of the losses, respectively (NASS 2011). Those losses represent direct costs to the producer (*e.g.*, value of the animal and its wool or mohair). Livestock producers often incur indirect costs associated with livestock predation in addition to the direct loss from animals killed by predators, such as the implementation of methods to reduce predation rates (Jahnke et al. 1987). Economic losses associated with predation on livestock often occur despite efforts by livestock producers to reduce predation rates. Predation results in lost profitability for livestock producers because of decreases in the number of animals available for sale plus the costs of mitigating the predation (Rashford et al. 2010).

In 2010, predation on cattle throughout the United States resulted in losses totaling $98.5 million, while at the same time ranchers and farmers spent $189 million on non-lethal predator damage management measures such as guard animals and fencing (NASS 2011). The NASS (2005) reported that Oklahoma sheep producers used non-lethal methods to reduce predator damage. Producers in Oklahoma used night penning, guard dogs, llamas, fencing, donkeys, frequent checks, lamb shed, culling, bedding change, carrion removal, herding, and other non-lethal methods to reduce predation. In 2014, the APHIS Veterinary Services (2015) reported that Oklahoma sheep producers used guard dogs, llamas, donkeys, fencing, lamb shed, herding, night penning, fright tactics, removing carrion, culling, change bedding, frequent checks, altered breeding season, and other non-lethal methods. The NASS (2011) also reported that Oklahoma cattle producers used guard animals, culling, frequent checks, carcass removal, exclusion fencing, fright tactics, herding, night penning, and other non-lethal methods to reduce predation.

In a 2-year study of goat production in South Texas, Guthery and Beasom (1978) reported predators, primarily coyotes, killed 33 to 95% of the known kid crop on pastures with no predator management. Overall, predation rates on goats in studies of goat losses in the absence of management exceeded 50% (Bodenchuk et. al. 2002). During short-term fencing tests conducted in Texas, Shelton and Wade (1979) reported that predators killed all of the kids and lambs within the study area.

In Oklahoma, the NASS (2011) reported 3,400 cattle and 10,500 calves were killed in 2010 by animal predators. The economic loss from animal predators in Oklahoma was estimated at $6.9 million in 2010 (NASS 2011). Coyotes were attributed to 35.7% of the cattle losses and 52.6% of the calves lost in Oklahoma. Livestock producers in the State attributed dogs to 19.5% of the cattle and 13.8% of the calves lost (NASS 2011). NASS (2011) reported that mountain lion and bobcat predation in Oklahoma accounted for 7.1% of the calves lost to animal predators. Cattle producers in Oklahoma reported using a number of non-lethal methods to reduce losses due to predators. The use of exclusion fencing was reported as being employed by 24.7% of Oklahoma cattle producers along with 41.8% reporting the use of guard animals (NASS 2011). Livestock producers in Oklahoma also used herding, night penning, and fright tactics to reduce the risk of predation (NASS 2011).

Hall (1979) reported the results of an intensive food habit study of coyotes in Louisiana and found that cattle/calf remains represented the seventh most widely occurring food item in coyote stomachs. Michaelson and Goertz (1977) found the remains of cattle and calves in 13% of the coyote stomachs analyzed for a food habit study of coyotes in northwest Louisiana.

Coyotes accounted for 93% of all lambs and ewes killed by predators on nine sheep bands in shed lambing operations in southern Idaho and 25% of those lambs and ewes killed were not fed upon (Nass 1977). Coyotes were also found to be the predominant predator on sheep during a study in New Mexico, where more than 43% of the lambs killed by coyotes were not fed upon (DeLorenzo and Howard 1977). Coyotes were also the primary predator on sheep throughout a Wyoming study and essentially the only predator during the winter (Tigner and Larson 1977). Connolly (1992) determined that only a fraction of the total predation attributable to coyotes is reported to or confirmed by WS.

In 2004, sheep producers in Oklahoma reported losing 1,000 sheep and 2,700 lambs to predators (NASS 2005). Predation by coyotes accounted for 600, or 60% of sheep, and 1,800 or 66.7% of the lambs killed by predators in the State, while dogs accounted for 400, or 40% of sheep, and 600, or 22.2% of the lambs killed. Sheep and lamb losses from predators in 2004 were valued at $145,000 and $157,000, respectively (NASS 2005). In 2009, sheep producers reported that animal predators killed 1,400 sheep and 2,300 lambs in Oklahoma valued at $225,000 and $133,000, respectively (NASS 2010).

Sheep and lambs remain vulnerable to predation throughout the year, particularly from coyotes and dogs (Henne 1975, Nass 1977, 1980, Tigner and Larson 1977, O'Gara et al. 1983). Without actions to manage predation losses, studies reveal that losses of adult sheep and lambs to predators can be as high as 8.4% and 29.3%, respectively (Henne 1975, Munoz 1977, O'Gara et al. 1983). Conversely, other studies indicate that sheep and lamb losses are much lower where wildlife damage management is applied (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Howard and Booth 1981).

The domestic cat has been found to transmit *Toxoplasma gondii* to both domestic and wild animal species. Cats have been found to be important reservoirs and the only species known to allow for the completion of the life cycle for the protozoan parasite *T. gondii* (Dubey 1973, Teutsch et al. 1979). Both feral and domiciled cats may be infected by this protozoan, but this infection is more common in feral cats. Fitzgerald et al. (1984) documented that feral cats transmitted *T. gondii* to sheep in New Zealand, resulting in ewes aborting fetuses. The authors also found *Sarcocystis* spp. contamination in the musculature of sheep. Dubey et al. (1995) found cats to be 68.3% positive for seroprevalence of *T. gondii* on swine farms in Illinois and the major reservoir for this disease. The main sources for infecting cats are thought to be birds and mice.

Neospora caninum is a protozoan parasite with a life cycle that is similar to *T. gondii*. *N. caninum* requires a canine host to complete its life cycle. In cattle, *N. caninum* can cause spontaneous abortions and it may be a leading cause of abortion in dairy cattle. In California, economic losses related to *N. caninum* could reach $35 million per year, while losses in Texas may range between $15 and $24 million (USDA 2012). The National Wildlife Disease Program within WS screened coyotes in Texas, Oklahoma, and New Mexico for *N. caninum* and found that 18% of the coyotes sampled had been exposed to *N. caninum* (Bevins et al. 2013).

Diseases that may be communicable from feral cats to companion cats include feline panleukopenia (FPL) infection, feline calicivirus infection, feline reovirus infection, and feline syncytium-forming virus infection (Gillespie and Scott 1973). Of the four feline diseases, feline panleukopenia is considered the most serious. Reif (1976) found that during the acute stages of feline panleukopenia, fleas were vectors of this disease to other cats. FPL infection is cyclic in nature, being more prevalent in the July to September period.

Need for Predator Damage Management to Alleviate Property Damage

Predators can cause damage to a variety of property types in Oklahoma each year. Property damage can occur in a variety of ways. Predator damage to property occurs primarily through direct damage to structures. Accumulations of fecal droppings can cause damage to buildings and other structures where raccoons or feral cats frequent. Aircraft striking predators can also cause substantial damage requiring costly repairs and aircraft downtime. Raccoons and skunks can cause damage to property by digging under porches, buildings, homes, and other places. Skunks and raccoons can cause damage to lawns and landscaping while digging for grubs and insects. Coyotes can attack companion animals.

Airports provide ideal conditions for many wildlife species due to the large open grassy areas around runways and taxiways adjacent to brushy, forested habitat used as noise barriers. Access to most airport properties is restricted so predator species living within airport boundaries are not harvestable during hunting and trapping seasons and insulated from many other human disturbances.

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

Between 1990 and 2014, there were 3,360 reported aircraft strikes involving terrestrial mammals in the United States (Dolbeer et al. 2015). The number of mammal strikes actually occurring is likely to be much greater, since Dolbeer (2009) estimated 39% of civil wildlife strikes are actually reported. Aircraft have collided with a reported 41 species of terrestrial mammals from 1990 through 2014, including raccoons, fox, cats, coyotes, dogs, and striped skunks (Dolbeer et al. 2015). Of the terrestrial mammals reported struck by aircraft, 37% were carnivores (primarily coyotes), causing over $4.3 million in damages (Dolbeer et al. 2015). Aircraft striking coyotes have resulted in 14,135 hours of aircraft downtime and nearly $3.8 million in damages to aircraft in the United States since 1990 (Dolbeer et al. 2015). Aircraft strikes involving dogs have caused over $400,000 in damage in the United States since 1990 (Dolbeer et al. 2015). Between 1990 and 2012, Crain et al. (2015) estimated that aircraft strikes involving carnivores (primarily coyotes) caused $7 million in damages to aircraft.

In addition to direct damage, an aircraft striking a predator can pose serious threats to human safety if the damage from the strike causes a catastrophic failure of the aircraft leading to a crash. For example, damage to the landing gear during the landing roll and/or takeoff run can cause a loss of control of the aircraft, causing additional damage to the aircraft and increasing the threat to human safety. Nearly 64% of the reported mammal strikes from 1990 through 2014 occurred at night, with most strikes occurring during the landing roll or the takeoff run (Dolbeer et al. 2015).

Since 1990, aircraft have struck eight coyotes, one domestic cat, eight skunks (species not indicated), 24 striped skunks, and one Virginia opossum in Oklahoma according to reports filed with the Federal

Aviation Administration (FAA) (FAA 2017). Airports and military facilities in Oklahoma could request assistance with managing threats to human safety and damage to property associated with predators present inside the area of operations of airports. The infrequency of predator strikes does not lessen the need to prevent threats to human safety and the prevention of damage to property. Preventing damage and reducing threats to human safety is the goal of those cooperators requesting assistance at airports in the State given that a potential strike could lead to the loss of human life and considerable damage to property.

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

The WS program could respond to requests from airports, landowners, and other property owners to alleviate property damage from predators in the State. WS could respond to requests for assistance associated with the threat of predators being struck by aircraft at airports, raccoons and skunks burrowing into or under homes, skunks and raccoons gaining access into a home through a pet door to eat pet food, and skunks causing damage to landscaping, gardens, and golf courses from feeding activities.

Predators can kill or injure pets and zoo animals, especially in urban and suburban areas. Predators in suburban and urban areas often have adapted to human altered habitats and have acclimated to the presence of people. For example, coyotes can be territorial and aggressive, especially during the breeding season and especially toward other canids, such as dogs. When coyotes adapt to and acclimate to the presence of people, they can act aggressive and attack pet dogs, even when people walk those dogs on a leash. Deer are a primary food source for mountain lions. Deer often thrive in urban and suburban areas due to availability of food and water. The presence of high deer densities in urban and suburban areas can attract mountain lions to those areas. Pets and zoo animals often are easy prey items for mountains lions because they are confined inside an enclosure or are generally less wary than other prey.

The digging and burrowing activities of badgers can severely damage levees, dikes, earthen dams, landfills, and other structures (Federal Emergency Management Agency 2005). Badgers burrowing into roadbeds and embankments could potentially weaken or cause the collapse of those structures. Additionally, badger burrows may cause damage to property when tractors and other equipment drop into a burrow or roll over due to a burrow.

Need for Predator Damage Management to Resolve Damage Occurring to Natural Resources

Natural resources can be those assets belonging to the public that government agencies, as representatives of the people, often manage and hold in trust. Such resources may be plants or animals, including threatened or endangered species, historic properties, or habitats in general. Examples of natural resources in Oklahoma are parks and recreation areas; natural areas, including unique habitats or topographic features; threatened or endangered plants and animals; and any plant or animal populations that have been identified by the public as a natural resource.

Predatory mammals can also cause damage to natural resources. Predators causing damage are often locally overabundant at the damage site and threaten the welfare of another species' population. An example of this would be nest predation of a local ground-nesting bird population by mammalian predators, such as raccoons, opossum, feral cats, mink, weasels, coyotes, or fox.

Predation is one of many mortality factors that influence wildlife populations. Predators often play critical roles in the composition and function of wildlife populations in ecosystems (Witmer et al. 1996). Normally, predation by native predators would be considered part of the function of a healthy ecosystem. Many of the predators addressed in this EA are native to the State of Oklahoma; however, many changes have occurred in the ecosystem of the State, which has disrupted natural predator-prey relationships. Many of the changes that have occurred can be attributed to human influence, including habitat fragmentation, landscape alteration, and environmental contamination. In addition, human habitation alone can often alter the biological carrying capacity of a local environment. Some species, such as raccoons and skunks, can live in high densities because of human activity. Those same human-induced changes can negatively affect the viability of some native wildlife populations.

Declines in bird populations associated with habitat loss and fragmentation may be compounded by predation (Cote and Sutherland 1997). The effects of predation on birds can be detrimental to local populations; especially, when predator densities are high or when predators gain access to areas not historically occupied (Stoudt 1982, Bailey 1993). In general, ground nesting birds suffer the highest predation rates (DeVos and Smith 1995).

Under some circumstances, managing predation can be an important tool in maintaining specific wildlife management objectives. Managing many wildlife species in Oklahoma is the responsibility of the ODWC and any decision to manage predation to benefit local game populations or other wildlife species would be the responsibility of the ODWC. However, WS could provide assistance if requested by the ODWC or another federal agency. A major goal of WS would be to provide protection and conduct actions in areas where data suggests that managing predators would likely be effective and successful (Ballard et al. 2001).

WS could receive requests to assist with preventing predation on other wildlife species. If a management agency finds that predation could adversely affect a particular species, WS could assist in determining if damage management efforts could help protect the species and implement necessary, if any, actions to prevent predation. In many cases, requests for assistance to manage damage to natural resources involve threatened or endangered species.

Need for Predator Damage Management to Protect Human Health and Safety

Zoonoses (*i.e.*, diseases of animals that can be transmitted to people) can often be a major concern of cooperators when requesting assistance with managing threats from predators. Disease transmission could occur from direct interactions between people and predators or from interactions with pets and livestock that have direct contact with wild predators. Pets and livestock often encounter and interact with other animals, which can increase the opportunity of transmission of disease to people. Table 1.3 shows common diseases that could affect people that predators could transmit in addition to diseases that could affect other animals, including domestic species. Those threats include viral, bacterial, mycotic (fungal), protozoal, and rickettsial diseases.

Individuals or property owners that request assistance with disease threats frequently are concerned about potential disease risks but are unaware of the types of diseases that can be transmitted by those animals. In those types of situations, assistance is requested because of a perceived risk to human health or safety associated with wild animals living in close association with people, from animals acting out of character by roving in human-inhabited areas during daylight, or from animals showing no fear when people are present. Under the proposed action, WS could assist in resolving those types of requests for assistance.

Table 1.3 - Wildlife diseases in the Eastern United States that pose potential health risks through transmission to people (Beran 1994, Davidson 2006)†

Disease	Causative Agent	Hosts‡	Human Exposure
Anthrax	*Bacillus antracis*	cat, dog	inhalation, ingestion
Tetanus	*Clostridium tetani*	mammals	direct contact
Dermatophilosis	*Dermatophilus congolensis*	mammals	direct contact
Pasteurellaceae	*Haemophilus influenzae*	mammals	bite or scratch
Salmonellosis	*Salmonella* spp.	mammals	ingestion
Yersinosis	*Yersinia* spp.	cat	ingestion
Chlamydioses	*Chlamydophilia felis*	cat	inhalation, direct contact
Typhus	*Rickettsia prowazekii*	opossum	inhalation, ticks, fleas
Sarcoptic mange	*Sarcoptes scabiei*	red fox, coyote, dog	direct contact
Trichinosis	*Trichinella spiralis*	raccoon, fox	ingestion, direct contact
Rabies	*Lyssavirus* spp.	mammals	direct contact
Visceral larval	*Baylisascaris procyonis*	raccoon, skunk	ingestion, direct contact
Leptospirosis	*Leptospira interrogans*	mammals	ingestion, direct contact
Echinococcus	*Echinococcus multilocularis*	fox, coyote	ingestion, direct contact
Toxoplasmosis	*Toxoplasma ondii*	cat, mammals	ingestion, direct contact
Spirometra	*Spirometra mansonoides*	bobcat, raccoon, fox	ingestion, direct contact
Giardiasis	*Giardia lamblia, G. duodenalis*	mammals	ingestion, direct contact

†Table 1.4 is not an exhaustive list of wildlife diseases considered infectious to people. The zoonoses provided are the more common infectious diseases for the species addressed in this EA and are only a representation of the approximately 100 to 3,000 zoonoses known to exist.

‡ The host species provided for each zoonosis includes only those mammalian species addressed in this EA unless the zoonoses listed potentially infects a broad range of mammalian wildlife. The use of the general term "*mammals*" as the host species denotes zoonoses that could infect a broad range of mammals. The diseases listed do not necessarily infect only those mammalian species covered under this EA but likely infect several species of mammals or groups of mammals. For a complete discussion of the more prevalent diseases in free-ranging mammals, please refer to Beran (1994) and Davidson (2006).

In many circumstances when human health concerns are the primary reason for requesting WS' assistance there may have been no actual cases of transmission of disease to people by predators. Thus, the risk of disease transmission would be the primary reason for requesting assistance from WS. Situations in Oklahoma in which the threat of disease associated with predator populations may include:

- Exposure of residents to the threat of rabies due to high population densities of skunks in an area, denning skunks, or from companion animals encountering infected skunks..
- Exposure of people to the threat of rabies posed by coyotes that live in urban or rural areas of the state or from companion animals that may come in contact with coyotes.
- Exposure of people to the threat of plague (*Yersinia pestus*) posed by coyotes in urban or rural areas of the state or from companion animals that may come in contact with infected coyotes.
- Threats of infections to people from toxoplasmosis and other diseases could occur from high feral cat populations in a park or recreation area.
- Accumulated droppings from denning or foraging raccoons and the subsequent exposure of the public to raccoon roundworm in fecal deposits.

The most common disease concern expressed by individuals requesting assistance is the threat of rabies transmission to people, pets, and livestock. Rabies is an acute, fatal viral disease of mammals most often transmitted through the bite of a rabid animal that poses an indirect and direct threat to people. Indirect threats to people occur from exposure to pets or livestock that have been infected from bites of a rabid animal. Direct threats can occur from handling infected wildlife or from aggressive animal behavior caused by rabies. The disease can be effectively prevented in people when exposure is identified early and treated. In addition, domestic animals and pets can be vaccinated for rabies. However, the abundant and widely distributed reservoir among wild mammals complicates rabies control. The vast majority of rabies cases reported to the Centers for Disease Control and Prevention (CDC) each year occur in raccoons, skunks (primarily *Mephitis mephitis*), and bats (Order Chiroptera) (CDC 2011).

Over the last 100 years, the vector of rabies in the United States has changed dramatically. About 90% or greater of all animal cases reported annually to CDC now occur in wildlife (Krebs et al. 2000, CDC 2011). Before 1960, the majority of cases the CDC received occurred in domestic animals. The principal rabies hosts today are wild carnivores and bats. The number of rabies-related human deaths in the United States has declined from more than 100 annually in the early 1900s to an average of one or two people per year in the 1990s. Modern day prophylaxis, which is the series of vaccine injections given to people who have been potentially or actually exposed, has proven nearly 100% successful in preventing mortality when administered promptly (CDC 2011). In the United States, human fatalities associated with rabies occur in people who fail to seek timely medical assistance, usually because they were unaware of their exposure to rabies. Although human rabies deaths are rare, the estimated public health costs associated with disease detection, prevention, and control have risen, exceeding $300 million annually. Those costs include the vaccination of companion animals, maintenance of rabies laboratories, medical costs such as those incurred for exposure case investigations, rabies post-exposure prophylaxis (PEP), and animal control programs (CDC 2011).

Accurate estimates of the aforementioned expenditures are not available. Although the number of PEPs given in the United States each year is unknown, it has been estimated to be as high as 40,000. When rabies becomes epizootic (*i.e*., affecting a large number of animals over a large area) or enzootic (*i.e*., present in an area over time but with a low case frequency) in a region, the number of PEPs in that area often increases. Although the cost varies, a course of rabies immunoglobulin and five doses of vaccine given over a 4-week period typically exceeds $1,000 (CDC 2011) and has been reported to be as high as $3,000 or more (Meltzer 1996). As epizootics spread in wildlife populations, the risk of "*mass*" human exposures requiring treatment of large numbers of people that contact individual rabid domestic animals infected by wild rabid animals increases. One case in Massachusetts involving contact with, or drinking milk from, a single rabid cow required PEPs for 71 people (CDC 1999). The total cost of this single incident exceeded $160,000 based on a median cost of $2,376 per PEP in Massachusetts. Likely, the most expensive single mass exposure case on record in the United States occurred in 1994 when a kitten from a pet store in Concord, New Hampshire tested positive for rabies after a brief illness. Because of potential exposure to the kitten or to other potentially rabid animals in the store, at least 665 persons received post-exposure rabies vaccinations at a total cost of more than $1.1 million (Noah et al. 1995). The American Veterinary Medical Association (AVMA) estimated the total cost for this specific incident, including investigation, laboratory testing, and rabies immunoglobulin and vaccines was more than $1.5 million (AVMA 2004).

Rabies presents a human health threat through potential direct exposure to rabid animals, or indirectly through the exposure of pets that have an encounter with rabid animals. Additionally, the number of pets and livestock examined and vaccinated for rabies, the number of diagnostic tests requested, and the number of post exposure treatments can increase when rabies is present in an area. Human and financial resources allocated to rabies-related human and animal health needs also increase, often at the expense of other important activities and services.

Skunks are an important wildlife host for the rabies virus in North America and are second only to raccoons in being the most commonly reported rabid wildlife species in the United States (Majumdar et al. 2005). The skunk variant of rabies occurs in the Midwest and California; however, skunks found throughout North America may be infected with different variants of rabies such as the raccoon variant. The distribution of rabies in skunks extends from Georgia to Maine east of the Appalachians, Texas to the Canadian border, and throughout the northern two thirds of California, including Oklahoma (Majumdar et al. 2005).

Increasing populations of raccoons have been implicated in the outbreak of distemper in certain areas (Majumdar et al. 2005). Distemper has not been identified as transmissible to people. However, people who feel threatened by the possibility of disease transmission often request assistance after observing sick raccoons on their property. Symptoms of distemper often lead to abnormal behavior in raccoons that are similar to symptoms associated with rabies. Raccoons with distemper often lose their fear of people and can act aggressively, which increases the risk to people, livestock, or companion animals from bites. Distemper can also occur in coyotes, red fox, and gray fox with symptoms that are similar to those symptoms exhibited by animals infected with the rabies virus.

Diseases and parasites affecting feral cats and dogs can have particularly serious implications to human health given the close association of those animals with people and companion animals. The topic of feral animals and their impacts on native wildlife and human health elicits a strong response in numerous professional and societal groups with an interest in the topic. 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, a segment of society views feral animals to be an extension of companion animals that should be cared for and for which affection bonds are often developed, especially when societal groups feed and care for individual feral animals. Of special concern are those cats and dogs considered companion animals that are not confined indoors at all times but are allowed to range outside the home for extended periods. If interactions occur between companion animals and feral animals of the same species, companion animals could become exposed to a wide-range of zoonoses that could be brought back into the home where direct contact between the companion animal and people increases the likelihood of disease transmission. Feral animals that are considered companion animals are also likely to affect multiple people if disease transmission occurs since those animals are likely to come in direct contact with several members of families and friends before diagnosis of a disease occurs.

Several known diseases that are infectious to people, including rabies, have been found in feral cats and dogs. A common zoonosis found in cats is ringworm. Ringworm (*Tinea* spp.) is a contagious fungal disease contracted through direct interactions with an infected person, animal, or soil. Other common zoonoses of cats are pasteurella, salmonella, cat scratch disease, and numerous parasitic diseases, including roundworms, tapeworms, and toxoplasmosis.

This discussion on zoonoses is intended to briefly address the more common known zoonoses found in the United States for those species specifically addressed in this EA but is not intended to be an exhaustive discussion of all potential zoonoses. The transmission of diseases from wildlife to humans is neither well documented nor well understood for most infectious zoonoses. Determining a vector for a human infected with a disease known to occur in wildlife populations is often complicated by the presence of the known agent across a broad range of naturally occurring sources. For example, a person with salmonella poisoning may have contracted salmonella bacterium from direct contact with an infected pet but may have also contracted the bacterium from eating undercooked meat or from other sources.

Disease transmission directly from wildlife to people is uncommon. However, the infrequency of such transmission does not diminish the concerns of those people fearful of exposure requesting assistance since disease transmission could occur. WS actively attempts to educate the public about the risks associated with disease transmission from wildlife to people through technical assistance and by providing technical leaflets on the risks of exposure.

In addition to disease transmission threats, WS also receives requests for assistance from perceived threats of physical harm from wildlife, especially from predatory wildlife. Human encroachment into wildlife habitat increases the likelihood of human-wildlife interactions. Those species that people are likely to encounter are those most likely to adapt to and thrive in human altered habitat. Several predatory and omnivorous wildlife species thrive in urban habitat due to the availability of food, water, and shelter. Many people enjoy wildlife to the point of purchasing food specifically for feeding wildlife despite laws prohibiting the act in many areas. The constant presence of human created refuse, readily available water supplies, and abundant rodent populations found in some areas often increases the survival rates and carrying capacity of wildlife species that are adaptable to those habitats. Often the only limiting factor of wildlife species in and around areas inhabited by people is the prevalence of diseases. Overabundant wildlife that congregate into small areas because of the unlimited amount of food, water, and shelter can confound the prevalence of diseases.

As people are increasingly living with wildlife, the lack of harassing and threatening behavior by people toward many species of wildlife has led to a decline in the fear wildlife have toward people. When wildlife species begin to habituate to the presence of people and human activity, a loss of apprehension occurs that can lead to threatening behavior toward people. This threatening behavior continues to increase as human populations expand and the populations of those species that adapt to human activity increase. Threatening behavior can be in the form of aggressive posturing, a general lack of apprehension toward people, or abnormal behavior. Although wildlife attacking people occurs rarely, the number of attacks appears to be on the increase. Coyotes have been known to threaten and attack people in urbanized situations (Loven 1995, Baker and Timm 1998). Poessel et al. (2013) discusses the emerging conflicts between people and coyotes in the metropolitan area of Denver, Colorado. Timm et al. (2004) reported that coyotes attacking people have increased in California and the recent, highly publicized coyote attacks, including a fatal attack on a 19-year old woman in Nova Scotia (Canadian Broadcast Company 2009), have only heightened people’s awareness of the threat of such encounters.

Black bears occasionally threaten human health and safety. Herrero (1985) documented 500 injuries to humans resulting from encounters with black bears from 1960 to 1980. Of those injuries, 90% were considered minor (*e.g.*, minor bites, scratches, and bruises) by Herrero (1985). Only 23 fatalities were recorded from 1900 to 1980 due to black bear attacks. Of those fatalities, 90% were likely associated with habituated, food-conditioned bears. The number of bear attacks could be considered low considering the geographic overlap of human and black bear populations.

Although attacks on people associated with those species addressed in this EA occurs rarely, requests for assistance to lessen the threat of possible attack do occur from people in the State. Often, wildlife exhibiting threatening behavior or a loss of apprehensiveness to the presence of people is a direct result and indication of an animal inflicted with a disease. Requests for assistance therefore could occur from a desire to reduce the threat of disease transmission and/or from fear of aggressive behavior from an animal that is less apprehensive of people or induced as a symptom of disease.

WS has received requests for assistance in the State to reduce human health and safety concerns. Human health and safety concerns may include attacks from coyotes that result in injuries or death, disease threats from rabies and plague outbreaks where predators act as reservoirs, odor and noise nuisances from skunks, opossums, and raccoons in attics and under houses, and aircraft strike hazards from coyotes and fox crossing runways at airports or airbases. Typically, the biggest concern of the public is the threat of attack on people by large predators (*e.g.*, coyotes) despite the rarity of those types of events. For example, Baker and Timm (1998), after several human-coyote interactions in an area, concluded that the use of foothold traps to capture and euthanize a few coyotes would be the best method to limit interactions and have the most lasting effects. After a coyote in Glendale, California, killed a child, city and county officials trapped 55 coyotes in an 80-day period from within one-half mile of the home, an unusually high number for such a small area (Howell 1982). No fatalities associated with predators have been documented in the State. Although predator attacks on people are rare, WS could receive requests for assistance if such attacks occur.

Disease Surveillance and Monitoring

Public awareness and the health risks associated with zoonoses have increased in recent years. This EA addresses several zoonotic diseases associated with predators. Those zoonotic diseases remain a concern and continue to pose threats to human safety where people encounter predators. WS has received requests to assist with reducing damage and threats associated with several predator species in Oklahoma and could conduct or assist with disease monitoring or surveillance activities for any of the predator species addressed in this EA. Most disease sampling would occur ancillary to other wildlife damage management activities (*i.e.*, disease sampling would occur after wildlife have been captured or lethally removed for other purposes). For example, WS may sample predators harvested during the annual hunting season or collect samples during other damage management programs. These samples collected by WS could be tissue, blood, and parasites.

1.3 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

Actions Analyzed

This EA documents the need for managing damage caused by predators, the issues associated with meeting that need, and alternative approaches to address those issues and to meet the need for action. WS' mission is to provide federal leadership with managing damage and threats of damage associated with animals (see WS Directive 1.201). The WS program has developed a Policy Manual to provide guidance to WS' personnel conducting official activities (see WS Directive 1.101). The Policy Manual addresses national policy and provides general direction to WS' personnel. WS' personnel would only provide assistance when the appropriate property owner or manager requested WS' assistance[6]. WS could receive a request for assistance from a property owner or manager to conduct activities on property they own or manage, which could include federal, state, tribal, county, municipal, and private land within the State of Oklahoma.

Appendix B of this EA discusses the methods available for use or recommendation under each of the alternative approaches evaluated[7]. The alternatives and Appendix B also discuss how WS and other entities could recommend or employ methods to manage damage and threats associated with predators in the State. Therefore, the actions evaluated in this EA are the use or recommendation of those methods available under the alternatives and the employment or recommendation of those methods by WS to manage or prevent damage and threats associated with predators from occurring when requested by the appropriate resource owner or manager. Activities that could involve the lethal removal of target predator species by WS under the alternatives would only occur when agreed upon by the requester and when authorized by the ODWC, when required, and only at levels authorized.

[6]Prior to providing any direct operational assistance, a MOU, Work Initiation Document, Work plan, or another similar document would be signed between WS and the appropriate property owner or manager that identifies the wildlife species to be addressed and the methods the cooperator has agreed to be implemented on property they own or manage.

[7]Appendix B contains a complete list of chemical and non-chemical methods available for use under the identified alternatives. However, listing methods neither implies that all methods would be used by WS to resolve requests for assistance nor does the listing of methods imply that all methods would be used to resolve every request for assistance.

Native American Lands and Tribes

The WS program in Oklahoma would only conduct damage management activities on Native American lands when requested by a Native American Tribe. WS would only conduct activities after WS and the Tribe requesting assistance signed a Memorandum of Understanding (MOU), a work initiation document, or a similar document. Therefore, the Tribe would determine what activities would be allowed and when WS' assistance was required. Because Tribal officials would be responsible for requesting assistance from WS and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would likely occur. Those methods available to alleviate damage associated with predators on federal, state, county, municipal, and private properties under the alternatives analyzed in this EA would be available for use to alleviate damage on Tribal properties when the Tribe requesting WS' assistance approved the use of those methods. Therefore, the activities and methods addressed under the alternatives would include those activities that WS could employ on Native American lands, when requested and when agreed upon by the Tribe and WS.

Period for which this EA is Valid

If the preparation of an Environmental Impact Statement (EIS) is not warranted, based on the analyses associated with this EA, WS would conduct reviews of activities conducted under the selected alternative to ensure those activities occurred within the parameters evaluated in this EA. This EA would remain valid until WS and the ODAFF, in consultation with the ODWC, determined that new needs for action, changed conditions, new issues, or new alternatives having different environmental impacts must be analyzed. At that time, WS and the ODAFF would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Under the alternative analyzing no involvement by WS, no review or additional analyses would occur based on the lack of involvement by WS. The monitoring of activities by WS would ensure the EA remained appropriate to the scope of damage management activities conducted by WS in Oklahoma under the selected alternative.

Site Specificity

As mentioned previously, WS would only conduct damage management activities when requested by the appropriate resource owner or manager. In addition, WS' activities that could involve the lethal removal of predators under the alternatives would only occur when authorized by the ODWC, when required, and only at levels authorized.

This EA analyzes the potential impacts of managing damage caused by predators based on previous activities conducted on private and public lands in Oklahoma where WS and the appropriate entities entered into a MOU, work initiation document, annual work plan, or a similar document. This EA also addresses the potential impacts of managing predator damage in areas where WS and a cooperating entity could sign additional agreements in the future. Because the need for action would be to reduce damage and because the program's goals and directives would be to provide assistance when requested, within the constraints of available funding and workforce, it is conceivable that additional damage management efforts could occur. Thus, this EA anticipates those additional efforts and analyzes the potential effects of those efforts as part of the alternatives.

Many of the predator species addressed in this EA occur statewide and throughout the year in the State; therefore, damage or threats of damage could occur wherever those predators occur. Planning for the management of predator damage must be viewed as being conceptually similar to the actions of other entities whose missions are to stop or prevent adverse consequences from anticipated future events for which the actual sites and locations where they would occur are unknown but could be anywhere in a defined geographic area. Examples of such agencies and programs include fire departments, police departments, emergency clean-up organizations, and insurance companies. Although WS and the ODAFF could predict some locations where predator damage would occur, WS and the ODAFF could not predict every specific location or the specific time where such damage would occur in any given year. In addition, the threshold triggering an entity to request assistance from WS to manage damage associated with predators is often unique to the individual; therefore, predicting where and when WS would receive such a request for assistance would be difficult. This EA emphasizes major issues as those issues relate to specific areas whenever possible; however, many issues apply wherever predator damage and the resulting management actions occur and this EA treats those issues as such.

Chapter 2 of this EA identifies and discusses issues relating to predator damage management in Oklahoma. The standard WS Decision Model (Slate et al. 1992; see WS Directive 2.201) would be the site-specific procedure for individual actions that WS could conduct in the State (see Chapter 3 for a description of the Decision Model and its application). Decisions made using the model would be in accordance with WS' directives (see WS Directive 1.101) and Standard Operating Procedures (SOPs) described in this EA, as well as relevant laws and regulations in accordance with WS Directive 2.210.

The analyses in this EA would apply to any action that may occur by WS in any locale and at any time within Oklahoma. In this way, WS believes this EA meets the intent of the NEPA with regard to site-specific analysis and that this is the only practical way for WS to comply with the NEPA and still be able to accomplish the mission of the program.

Summary of Public Involvement

WS, in cooperation with the ODAFF, initially developed the issues associated with conducting activities to manage damage in consultation with the ODWC. WS and the ODAFF defined the issues and identified the preliminary alternatives through the scoping process. As part of this process, and as required by the Council on Environmental Quality (CEQ) and APHIS implementing regulations for the NEPA, WS and the ODAFF will make this document available to the public for review and comment. WS and the ODAFF will make the document available to the public through legal notices published in local print media, through direct notification of parties that have requested notification, or that WS and the ODAFF have identified as having a potential interest in the reduction of threats and damage associated with predators in the State. In addition, WS will post this EA on the APHIS website and the regulations.gov website for review and comment.

WS will provide for a minimum of a 30-day comment period for the public and interested parties to provide new issues, concerns, and/or alternatives. Through the public involvement process, WS and the ODAFF will clearly communicate to the public and interested parties the analyses of potential environmental impacts on the quality of the human environment. WS and the ODAFF would fully consider new issues, concerns, or alternatives the public identifies during the public involvement period to determine whether WS and the ODAFF should revisit the EA and, if appropriate, revise the EA prior to issuance of a Decision.

1.4 RELATIONSHIP OF THIS EA TO OTHER DOCUMENTS

WS' Environmental Assessment – Predator Damage Management in Oklahoma

As was stated previously, WS previously developed an EA that addressed WS' activities to manage damage associated with predators in the State. This new EA will address more recently identified changes in activities and will assess the potential environmental impacts of program alternatives based on those changes, primarily a need to evaluate new information. Since this new EA will re-evaluate activities conducted under the previous EA to address the new need for action and the associated affected environment, the analysis and the outcome of the Decision issued based on the analyses in this EA will supersede the previous EA that addressed managing damage caused by predators.

WS' Environmental Assessment – Aquatic Rodent Damage Management in Oklahoma

An EA was prepared by WS to evaluate alternatives for the reduction of beaver (*Castor canadensis*), nutria (*Myocastor coypus*), and muskrat (*Ondatra zibethicus*) damage to property, agricultural and natural resources, and threats to public health and safety in the State of Oklahoma (USDA 2015*a*). The EA evaluated the need for WS' activities and the relative effectiveness of three alternatives to meet that proposed need, while accounting for the potential environmental effects of those activities. The proposed action in the EA describes an integrated methods approach to managing damage associated with beaver, nutria, and muskrats in which a variety of methods would be used or recommended to reduce damage. Although, beaver, nutria, and muskrats are not directly addressed in this EA, many of the methods available to meet the need for action are similar to methods available under this EA.

National Level Memoranda of Understanding

National level MOUs have been signed between WS and the Bureau of Land Management (BLM), between WS and the United States Forest Service, and between WS and the United States Fish and Wildlife Service (USFWS), which recognize WS' responsibilities for wildlife damage management and related compliance with the NEPA, and outline related roles and responsibilities of each agency.

National Forest Land and Resource Management Plans

The National Forest Management Act requires that each National Forest prepare a Land and Resource Management Plan for guiding long-range management and direction.

BLM Resource Management Plans

The BLM currently uses Resource Management Plans to guide land management decisions on lands it administers. Any work planned on BLM managed lands would be further coordinated with BLM per the national level MOU.

Oklahoma Comprehensive Wildlife Conservation Strategy

The ODWC has developed an extensive wildlife conservation plan that evaluates species of plants and animals within the State (ODWC 2005). WS consulted the Comprehensive Wildlife Conservation Strategy (ODWC 2005) as part of this analysis and the alternatives would be consistent with the plan.

Oklahoma Bobcat Management Plan

Mouser and Schofield (2015) have developed a management plan for bobcats within the State. One of the goals of the plan is to "*manage the bobcat population in Oklahoma in a sustainable way for future generations*".

Oklahoma Biodiversity Plan

As stated in the plan, "*The primary purpose of this plan is to provide information about Oklahoma's biodiversity and make recommendations on how biodiversity conservation can be included in a variety of economic and other activities*".

1.5 AUTHORITY OF STATE AND FEDERAL AGENCIES

Below are brief discussions of the authorities of WS, the ODAFF, and other agencies, as those authorities relate to conducting wildlife damage management.

WS' Legislative Authority

The primary statutory authority for the WS program is the Act of March 2, 1931 (46 Stat. 1468; 7 USC 8351-8352) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 8353). The WS program is the lead federal authority in managing damage to agricultural resources, natural resources, property, and threats to human safety associated with wildlife. WS' directives define program objectives and guide WS' activities when managing wildlife damage (see WS Directive 1.201, WS Directive 1.205, WS Directive 1.210). In Oklahoma, WS is authorized and permitted to take necessary action in assisting a cooperator with wildlife damage management pursuant to the provisions in Section 5-201 and Section 5-502 of Title 29 in the Oklahoma Statutes (OS).

United States Environmental Protection Agency (EPA)

The EPA is responsible for implementing and enforcing the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which regulates the registration and use of pesticides.

United States Forest Service and Bureau of Land Management

The United States Forest Service and the BLM have the responsibility to manage the resources on federal lands under their jurisdictions for multiple uses including livestock grazing, timber production, recreation, and wildlife habitat, while recognizing the authority of the ODWC to manage resident wildlife populations. Both the United States Forest Service and the BLM recognize the importance of reducing wildlife damage on lands and resources under their jurisdictions, as integrated with their multiple use responsibilities. For these reasons, both agencies have entered into MOUs with WS nationally to facilitate a cooperative relationship.

Oklahoma Department of Wildlife Conservation

The ODWC has the responsibility to manage all protected and classified wildlife in Oklahoma, except federally listed threatened or endangered species, regardless of the land class on which the animals are found (OS Title 29, §5-412, 412.1). The ODWC is authorized to cooperate with WS and ODAFF for controlling predatory animals (OS Title 29, §3-103,105, §4-135). The ODWC also issues permits, including those for aerial hunting per the Fish and Wildlife Act of 1956, as amended, to landowners, lawful tenants, and lessees to take predatory animals (OS Title 29, §4-135). However, furbearers (badger, bobcat, fox, mink, opossum, raccoon, skunk, and weasel) found destroying livestock can be taken immediately without a permit by the public (OS Title 29, §5-405). Coyotes are not protected in Oklahoma and are classified as predatory animals by definition under OS Title 29, §2-132.

Oklahoma Department of Agriculture, Food and Forestry

The ODAFF is authorized by Title 2, OS §12-1, A, to independently enter into cooperative agreements for the purpose of "*…conducting wildlife damage management for…other wildlife species causing destruction to livestock, poultry, crops, range land, forests and other resources, including human health and safety*". It further states that "*Wildlife damage management of …other wildlife species causing damage shall include but not be limited to hunting, trapping, or other practical methods for the control of wildlife damage*." The ODAFF maintains an internal State Wildlife Services Division that conducts activities in the State ti alleviate wildlife damage. In addition, the ODAFF currently has an MOU and an Annual Work Plan with WS. Those documents establish a cooperative relationship between WS and the ODAFF, outline responsibilities, and set forth annual objectives and goals of each agency for resolving requests for assistance to manage damage caused by wildlife in Oklahoma. The ODAFF also issues permits, including those for aerial hunting per the Fish and Wildlife Act of 1956, as amended, to allow permittees to take depredation animals (OS Title 29, §4-107.2).

Oklahoma State Department of Health

The Oklahoma State Department of Health has the authority to enter into an agreement with WS for conducting wildlife damage management for the protection of human health from wildlife threats.

1.6 COMPLIANCE WITH LAWS AND STATUTES

Several laws or statutes would authorize, regulate, or otherwise affect WS' activities under the alternatives. WS would comply with applicable federal, state, and local laws and regulations in accordance with WS Directive 2.210. Below are brief discussions of those laws and regulations that would relate to damage management activities that WS could conduct in the State.

National Environmental Policy Act

All federal actions are subject to the NEPA (Public Law 9-190, 42 USC 4321 et seq.). WS follows the CEQ regulations implementing the NEPA (40 CFR 1500 et seq.) along with the USDA (7 CFR 1b) and the APHIS implementing guidelines (7 CFR 372) as part of the decision-making process. Those laws, regulations, and guidelines generally outline five broad types of activities that federal agencies must accomplish as part of any project: public involvement, analysis, documentation, implementation, and monitoring. The NEPA also sets forth the requirement that all major 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. In part, the CEQ, through regulations in 40 CFR, Parts 1500-1508, regulate federal activities that could affect the physical and biological environment. In accordance with regulations of the CEQ and the USDA, the APHIS has published guidelines concerning the implementation of the NEPA (see 44 CFR 50381-50384).

Pursuant to the NEPA and the CEQ regulations, this EA 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 WS infuses the policies and goals of the NEPA into agency actions. WS prepared this EA by integrating as many of the natural and social sciences as warranted, based on the potential effects of the alternatives, including the potential direct, indirect, and cumulative effects of the alternatives.

Endangered Species Act

Under the Endangered Species Act (ESA), all federal agencies will seek to conserve threatened and endangered (T&E) species and will utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). WS conducts consultations with the USFWS pursuant to Section 7 of the ESA 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)). Evaluation of the alternatives in regards to the ESA will occur in Chapter 4 of this EA.

Bald and Golden Eagle Protection Act (16 USC 668)

Populations of bald eagles showed periods of steep declines in the lower United States during the early 1900s attributed to the loss of nesting habitat, hunting, poisoning, and pesticide contamination. To curtail declining trends in bald eagles, Congress passed the Bald Eagle Protection Act (16 USC 668) in 1940 prohibiting the take or possession of bald eagles or their parts. The Bald Eagle Protection Act was amended in 1962 to include the golden eagle and is now referred to as the Bald and Golden Eagle Protection Act. Certain populations of bald eagles were listed as "*endangered*" under the Endangered Species Preservation Act of 1966, which was extended when the modern ESA was passed in 1973. The "*endangered*" status was extended to all populations of bald eagles in the lower 48 States, except populations of bald eagles in Minnesota, Wisconsin, Michigan, Washington, and Oregon, which were listed as "*threatened*" in 1978. As recovery goals for bald eagle populations began to be reached in 1995, all populations of eagles in the lower 48 States were reclassified as "*threatened*". In 1999, the recovery goals for populations of eagles had been reached or exceeded and the eagle was proposed for removal from the ESA. The bald eagle was officially de-listed from the ESA on June 28, 2007 with the exception of the Sonora Desert bald eagle population. Although officially removed from the protection of the ESA across most of its range, the bald eagle is still afforded protection under the Bald and Golden Eagle Protection Act.

Under the Bald and Golden Eagle Protection Act (16 USC 668-668c), the take of bald eagles is prohibited without a permit from the USFWS. Under the Act, the definition of "*take*" includes actions that "*pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb*" eagles. The regulations authorize the USFWS to issue permits for the take of bald eagles and golden eagles on a limited basis (see 74 FR 46836-46837, 50 CFR 22.26, 50 CFR 22.27). Under the new regulations, WS may be required to apply for a non-purposeful take permit. This permit allows for any take that is associated with, but not the purpose of, an activity, when the take cannot practicably be avoided, and all advanced conservation practices have been implemented (see 50 CFR 22.26). As necessary, WS would apply for the appropriate permits as required by the Bald and Golden Eagle Protection Act.

Federal Insecticide, Fungicide, and Rodenticide Act

The FIFRA and its implementing regulations (Public Law 110-426, 7 USC 136 et. seq.) require the registration, classification, and regulation of all pesticides used in the United States. The EPA is responsible for implementing and enforcing the FIFRA. The EPA and the ODAFF regulate pesticides that could be available to manage damage associated with predators in the State.

National Historic Preservation Act of 1966, as amended

The National Historic Preservation Act (NHPA) and its implementing regulations (see 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 Section 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.

Native American Graves Protection 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.

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 animals 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 United States 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 drugs and euthanasia chemicals. 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.

Airborne Hunting Act

The Airborne Hunting Act, passed in 1971 (Public Law 92-159), and amended in 1972 (Public Law 92-502) added to the Fish and Wildlife Act of 1956 as a new section (16 USC 742j-l) that 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.

Environmental Justice in Minority and Low Income Populations - Executive Order 12898

Executive Order 12898 promotes the fair treatment of people of all races, income levels, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice is the pursuit of equal justice and protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. Executive Order 12898 requires federal agencies to make environmental justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income persons or populations. This EA will evaluate activities addressed in the alternatives for their potential impacts on the human environment and compliance with Executive Order 12898.

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. Federal agencies must make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. In addition, federal agencies must ensure agency policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

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.

Oklahoma Statutes - Animal Control Laws

Under Title 4, Section 41 of the OS states, "*It shall be lawful for a person to kill any animal of the family canidae* [dogs] *or the family felidae* [cats] *found chasing livestock off the premises of the owner of the animal if the person is the owner or occupant of the property on which the animal is chasing the livestock or if the person is authorized to kill such an animal by the owner or occupant of such property*." This law also holds the owner of these animals liable for damages sustained from them to livestock and other property. Additional laws can be enacted to control dogs running at large in counties with more than 200,000 people (Title 4, OS §43). In Oklahoma, dog control is generally the responsibility of local governmental agencies. Local animal control officials or County sheriffs are responsible for responding to dogs that threaten, damage, or kill livestock. When requested to assist with managing damage caused by feral or free-ranging dogs, WS would comply with WS Directive 2.340.

Under Title 29, Section 29-4-135, "*The* [ODWC] *is authorized to issue permits to landowners, lessees, or their designated agents and to any entity of state, county, or local government to control nuisance or damage by any species of wildlife including, but not limited to beaver, coyote, deer, bobcat, raccoon, and crow under rules promulgated by the Oklahoma Wildlife Conservation Commission. The permits may be issued without limitation by statewide season regulations, bag limits or methods of taking. A permitted landowner, lessee or a designated agent of the landowner or lessee may, with a valid permit issued pursuant to this section, control the wildlife specified in this subsection and feral swine at night to protect marketable agricultural crops, livestock, or processed feed, seed or other materials used in the production of an agricultural commodity*".

Under Title 29, Section 4-107.2, "*The* [ODAFF] *is authorized to issue a permit to a person to engage in the management of depredating animals by use of aircraft. The permit may be issued without limitation by statewide season regulations or bag limits. The permit shall be carried in the aircraft when performing management by the use of aircraft*."

1.7 DECISIONS TO BE MADE

Based on agency relationships, MOUs, and legislative authorities, WS is the lead agency for this EA, and therefore, responsible for the scope, content, and decisions made. The ODWC is responsible for managing wildlife in the State of Oklahoma. WS has consulted with and would continue to consult with the ODWC to ensure an interdisciplinary approach according to the NEPA and agency mandates, policies, and regulations. WS would coordinate activities to reduce and/or prevent predator damage in the State that could occur under the alternatives with the ODWC, which would ensure the ODWC has the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the State. In addition, the ODWC establishes and regulates hunting and trapping seasons in the State.

Based on the scope of this EA, the decisions to be made are: 1) should WS, in cooperation with the ODAFF, conduct predator damage management to alleviate damage when requested; 2) should WS, in cooperation with the ODAFF, implement an integrated methods approach to meet the need for action; 3) if not, should WS attempt to implement one of the other alternative approaches; and 4) would continuing the current approach to managing damage or implementing the other alternative approaches result in effects to the environment requiring the preparation of an EIS.

CHAPTER 2: AFFECTED ENVIRONMENT AND ISSUES

Chapter 2 contains a discussion of the issues, including issues that will receive detailed environmental impact analysis in Chapter 4 (Environmental Consequences), issues that have driven the development of SOPs, and issues that WS and the ODAFF did not consider in detail, with rationale. Pertinent portions of the affected environment will be included in this chapter in the discussion of the issues. Additional descriptions of the affected environment occur during the discussion of the environmental effects in Chapter 4.

2.1 AFFECTED ENVIRONMENT

Those predator species addressed in this EA are capable of utilizing a variety of habitats in the State. Most species of predators addressed in this EA occur throughout the year across the State where suitable habitat exists for foraging and shelter. Damage or threats of damage caused by those predator species could occur statewide in Oklahoma wherever those predators occur. However, under many of the alternative approaches discussed in Chapter 3, the WS program would only provide assistance when the appropriate landowner or manager requests such assistance and only on properties where WS and the entity requesting assistance signed a MOU, work initiation document, work plan, or another comparable document.

Upon receiving a request for assistance, WS could conduct activities to reduce predator damage or threats of damage on federal, state, tribal, municipal, and private properties in Oklahoma. Areas where damage or threats of damage could occur include, but would not be limited to agricultural fields, vineyards, orchards, farmyards, dairies, ranches, livestock operations, aquaculture facilities, fish hatcheries, grain mills, grain handling areas, railroad yards, waste handling facilities, industrial sites, natural resource areas, park lands, and historic sites; state and interstate highways and roads; railroads and their right-of-ways; property in or adjacent to subdivisions, businesses, and industrial parks; timberlands, croplands, and pastures; private and public property where burrowing predators cause damage to structures, dams, dikes, ditches, ponds, and levees; public and private properties in rural/urban/suburban areas where predators cause damage to landscaping and natural resources, property, and were a threat to human safety through the spread of disease. The area would also include airports and military airbases where predators were a threat to human safety and to property; areas where predators negatively affect wildlife, including T&E species; and public property where predators were negatively affecting historic structures, cultural landscapes, and natural resources. Chapter 4 also contains additional information on the affected environment.

Environmental Status Quo

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*" (see 40 CFR 1508.14). Therefore, when a federal action agency analyzes their potential impacts on the "*human environment*", it is reasonable for that agency to compare not only the effects of the proposed federal action, but also the potential impacts that occur or could occur in the absence of the federal action by a non-federal entity. This concept is applicable to situations involving federal assistance to reduce damage associated with animals.

Neither state nor federal laws protect some wildlife species, such as most non-native invasive species. State authority or law manages most predator species without any federal oversight or protection. In some situations, with the possible exception of restrictions on methods (*e.g*., firearms restrictions, pesticide regulations), unprotected wildlife species and certain resident wildlife species are managed with little or no restrictions, which allows anyone to lethally remove or take those species at any time when they are committing damage. The ODWC has the authority to manage wildlife populations in the State.

When a non-federal entity (*e.g.*, agricultural producers, municipalities, counties, private companies, individuals, or any other non-federal entity) takes an action to alleviate predator damage or threat of damage, the action is not subject to compliance with the NEPA due to the lack of federal involvement in the action. Under such circumstances, the environmental baseline or status quo would be an environment that includes those resources as other non-federal entities manage or affect those resources in the absence of the federal action. Therefore, in those situations in which a non-federal entity has decided that a management action directed towards predators should occur and even the particular methods that should be used, WS' involvement in the action would not affect the environmental status quo since the entity could take the action in the absence of WS' involvement. WS' involvement would not change the environmental status quo if the requester had conducted the action in the absence of WS' involvement in the action.

A non-federal entity could lethally remove predators to alleviate damage without the need for authorization when those species are non-native, are unregulated, or have no closed harvest season. In addition, other entities could remove predators to alleviate damage during the hunting and/or trapping season, and/or through authorizations by the ODWC. In addition, most methods available for resolving damage associated with predators would also be available for use by other entities. Therefore, WS' decision-making ability would be restricted to one of three alternatives. WS could take the action using the specific methods as decided upon by the non-federal entity, provide technical assistance only, or take no action. If WS' takes no action or provides just technical assistance, another entity could take the action anyway using the same methods without the need for authorization, during the hunting or trapping season, or through authorization by the ODWC. Under those circumstances, WS would have virtually no ability to affect the environmental status quo since the action would likely occur in the absence of WS' direct involvement.

Therefore, based on the discussion above, it is clear that in those situations where a non-federal entity has obtained the appropriate authorization, and has already made the decision to remove or otherwise manage predators to stop damage with or without WS' assistance, WS' participation in carrying out the action would not affect the environmental status quo.

2.2 ISSUES ASSOCIATED WITH PREDATOR DAMAGE MANAGEMENT ACTIVITIES

Issues are concerns regarding potential effects that might occur from a proposed action. Federal agencies must consider such issues during the NEPA decision-making process. Initially, WS, in cooperation with the ODAFF, developed the issues related to managing damage associated with predators in Oklahoma in consultation with the ODWC. In addition, WS and the ODAFF will invite the public to review and comment on the EA to identify additional issues.

Chapter 4 discusses the issues, as those issues relate to the possible implementation of the alternative approaches to meeting the need for action discussed in Chapter 1. WS and the ODAFF evaluated, in detail, the following issues.

Issue 1 - Effects of Damage Management Activities on Target Predator Populations

Maintaining viable populations of native species is a concern of the public and of biologists within the state and federal land and wildlife management agencies, including WS. Some authors and members of the public have expressed concern over unintentional ecological consequences from the predator damage management actions of WS (Bergstrom et al. 2014). Predators play a vital role in a healthy ecosystem; therefore, a common issue when addressing damage caused by wildlife is the potential impacts of the management actions on the populations of target predator species, including the potential effects of actions on the ability of people to harvest target predator species during the annual hunting and trapping seasons. Similarly, a concern often identified is the potential that activities would result in the loss of aesthetic benefits and non-consumptive uses (*e.g.*, wildlife watching, photographing) of target predators to the public, resource owners, or neighboring residents.

Under certain alternatives, WS could employ methods available to resolve damage and reduce threats to human safety that target an individual animal or a group of animals after applying the WS Decision Model (Slate et al. 1992) to identify possible techniques (see WS Directive 2.101, WS Directive 2.105, WS Directive 2.201, WS Directive 2.210). A common issue when addressing damage caused by animals is the potential impacts of management actions on the populations of target species and the potential effects on the ability of people to harvest target species during regulated seasons. Lethal and non-lethal methods would be available to resolve predator damage or threats to human safety. Non-lethal methods could disperse, translocate, or otherwise make an area unattractive to predators causing damage, which could reduce the presence of those predators at the site and potentially the immediate area around the site where an entity employed those methods. Employing lethal methods could remove a predatory animal or those predatory animals responsible for causing damage or posing threats to human safety. Therefore, the use of lethal methods could result in local population reductions in the area where damage or threats were occurring. The number of individual animals that WS' personnel could remove from a species' population using lethal methods would be dependent on the number of requests for assistance received, the number of individual animals involved with the associated damage or threat, the efficacy of methods employed, and the number of individuals the ODWC authorizes WS to remove.

Another concern is that activities conducted by WS would affect the ability of persons to harvest predators either by reducing local populations through the lethal removal of predators or by reducing the number of predators present in an area through dispersal techniques. People in the State can harvest most of the predators addressed in this EA during annual hunting and/or trapping seasons. People can harvest badgers, black bears, bobcats, coyotes, gray fox, raccoons, red fox, river otters, striped skunk, Virginia opossum, long-tailed weasels, and mink during annual hunting and/or trapping seasons. Coyotes and striped skunks have no closed season, which allows people to harvest those species throughout the year. The only species addressed in this EA that do not have hunting and/or trapping seasons in the State are mountain lions, swift fox, spotted skunks, hog-nosed skunks, ringtails, feral cats, and feral dogs.

Therefore, any damage management activities conducted by WS under the alternatives addressed would be occurring along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, mortality from regulated harvest, and human-induced alterations of wildlife habitat. Chapter 4 of this EA discusses the effects on the populations of target predator populations in the State from implementation of the alternatives addressed in detail.

Issue 2 - Effects of Predator Damage Management Activities on the Populations of Non-target Wildlife Species, Including T&E Species

The issue of non-target species effects, including effects on T&E species, arises from the use of non-lethal and lethal methods available for use under each of the alternatives. Appendix B of this EA describes the methods available for use under the alternatives. The use of non-lethal and lethal methods has the potential to inadvertently disperse, capture, or kill non-target animals. There are also concerns about the potential for adverse effects to occur to non-target animals from the use of chemical methods. Chemical methods that would be available for use to manage damage or threats associated with predators could include immobilizing drugs, euthanasia chemicals, sodium cyanide (coyotes, fox, feral dogs only) [8], fumigants (coyotes, red fox, striped skunks only), and repellents. Chapter 4 and Appendix B further discuss those chemical methods available for use to manage damage and threats associated with predators in Oklahoma. In addition, there are concerns regarding the potential effects of aircraft overflights on non-target wildlife from WS' use of aircraft. There may also be concerns that WS' activities could result in the capture or unintentional removal of eagles during WS' activities.

The ESA states that all federal agencies *"...shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act"* [Sec. 7(a)(1)]. WS conducts consultations with the USFWS pursuant to Section 7 of the ESA to ensure compliance. The WS program also conducts consultations 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 shall use the best scientific and commercial data available"* [Sec. 7(a)(2)].

As part of the scoping process for this EA, WS consulted with the USFWS pursuant to Section 7 of the ESA to facilitate interagency cooperation between WS and the USFWS. Chapter 4 of this EA discusses the potential effects of the alternatives on this issue.

Issue 3 - Effects of Predator Damage Management Activities on Human Health and Safety

An additional issue often raised is the potential risks to the safety of people associated with employing methods to manage damage caused by target species. Both chemical and non-chemical methods have the potential to have adverse effects on human safety. WS' employees could use and would recommend only those methods that were legally available under each of the alternatives. Still, some concerns exist regarding the safety of methods available despite their legality and selectivity. As a result, this EA will

[8] Sodium cyanide in M-44 devices (EPA Reg #56228-15) can only be used to manage damage associated with coyotes, red fox, and feral dogs and only when those species are vectors of a communicable disease, when predation occurs on livestock and poultry, or when predation occurs on federally-designated threatened or endangered species.

analyze the potential for proposed methods to pose a risk to the public. In addition to the potential risks to the public associated with the methods available under each of the alternatives, risks to WS' employees would also be an issue. Injuries to WS' employees could occur during the use of methods, as well as subject to workplace accidents. Selection of methods, under the alternatives, would include consideration for public and employee safety.

The issue of using chemical methods as part of managing damage associated with wildlife relates to the potential for human exposure either through direct contact with the chemical or from exposure to the chemical from animals that have been exposed. Under the alternatives identified, the use or recommendation of chemical methods could include immobilizing drugs, euthanasia chemicals, sodium cyanide (coyotes, fox, feral dogs only), fumigants (coyotes, red fox, striped skunks only), and repellents. The EPA through the FIFRA and the ODAFF through State laws would regulate pesticide use. The United States Drug Enforcement Administration and the United States Food and Drug Administration would regulate immobilizing drugs and euthanasia chemicals. In addition, the use of all chemical methods by WS would be subject to Oklahoma laws and WS' directives (see WS Directive 2.401, WS Directive 2.405, WS Directive 2.415, WS Directive 2.425, WS Directive 2.430, WS Directive 2.455, WS Directive 2.465).

Most methods available to alleviate damage and threats associated with predators would be non-chemical methods. Non-chemical methods may include cultural methods, limited habitat modification, animal behavior modification, and other mechanical methods. Changes in cultural methods could include improved animal husbandry practices, altering feeding schedules, changes in crop rotations, or conducting structural repairs. Limited habitat modification would be practices that alter specific characteristics of a localized area, such as removing bushes to eliminate shelter locations. Animal behavior modification methods would include those methods designed to disperse predators from an area through harassment or exclusion. Behavior modification methods could include pyrotechnics, propane cannons, barriers, electronic guards (Linhart et al. 1992), guard animals (Andelt 2004), effigies, and fladry (Mettler and Shivik 2007). Other mechanical methods could include cage traps, foothold traps, cable devices, shooting, or the recommendation that hunters and/or trappers reduce a local predator population during the annual hunting and/or trapping season.

The primary safety risk of most non-chemical methods occurs directly to the applicator or those persons assisting the applicator. However, risks to others do exist when employing non-chemical methods, such as when using firearms, pyrotechnics, or body-gripping traps. Most of the non-chemical methods available to address predator damage in Oklahoma would be available for use under any of the alternatives and by any entity, when authorized. Chapter 4 further discusses the risks to human safety from the use of non-chemical methods as this issue relates to the alternatives. Appendix B provides a complete list of non-chemical methods available to alleviate damage associated with predators.

Another concern is the threat to human safety from not employing methods or not employing the most effective methods to reduce the threats that predators could pose. The need for action in Chapter 1 addresses the risks to human safety from diseases associated with certain predator populations. The low risk of disease transmission from predators does not lessen the concerns of cooperators requesting assistance to reduce threats from zoonotic diseases. Increased public awareness of zoonotic events has only heightened the concern of direct or indirect exposure to zoonoses. Not adequately addressing the threats associated with potential zoonoses could lead to an increase in incidences of injury, illness, or loss of human life.

Additional concerns occur when inadequately addressing threats to human safety associated with aircraft striking predators at airports in the State. Predators have the potential to cause severe damage to aircraft, which can threaten the safety of passengers. Limiting or preventing the use of certain methods to address the potential for aircraft striking predators could lead to higher risks to passenger safety. Chapter 4 further evaluates those concerns in relationship to the alternatives.

Issue 4 - Humaneness and Animal Welfare Concerns of Methods

The issue of humaneness and animal welfare, as it relates to the killing or capturing of animals is an important but very complex concept that people can interpret in a variety of ways. The AVMA (2013) defines euthanasia as "…*ending the life of an individual animal in a way that minimizes or eliminates pain and distress*". Some people would prefer using AVMA accepted methods of euthanasia when killing all animals, including wild and invasive animals. Schmidt (1989) indicated that vertebrate damage management for societal benefits could be compatible with animal welfare concerns, if *"…the reduction of pain, suffering, and unnecessary death is incorporated in the decision making process."* Chapter 4 further discusses the issue of humaneness and animal welfare. Chapter 3 discusses SOPs intended to alleviate pain and suffering.

2.3 ISSUES CONSIDERED BUT NOT ANALYZED FOR EACH ALTERNATIVE

WS and the ODAFF identified additional issues during the scoping process of this EA. WS and the ODAFF considered those additional issues but a detailed analysis did not occur for the reasons provided. Discussion of those additional issues and the reasons for not analyzing those issues in detail occur below.

Appropriateness of Preparing an EA (Instead of an EIS) for Such a Large Area

The appropriateness of preparing an EA instead of an EIS was a concern WS and the ODAFF identified during the scoping process. Wildlife damage management falls within the category of actions in which the exact timing or location of individual activities can be difficult to predict well enough ahead of time to describe accurately such locations or times in an EA or even an EIS. Although WS and the ODAFF could predict some of the possible locations or types of situations and sites where some kinds of wildlife damage would occur, the program cannot predict the specific locations or times at which affected resource owners would determine a damage problem had become intolerable to the point that they request assistance from WS. In addition, the WS program would not be able to prevent such damage in all areas where it might occur without resorting to destruction of wild animal populations over broad areas at a much more intensive level than would be desired by most people, including WS, the ODAFF, and other agencies. Such broad scale population management would also be impractical or impossible to achieve within WS' policies and professional philosophies.

Ordinarily, according to the APHIS procedures implementing the NEPA, WS' individual wildlife damage management actions could be categorically excluded (see 7 CFR 372.5(c)). The intent in developing this EA has been to determine if the alternative approaches developed to meet the need for action could potentially have significant individual and/or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS. This EA addresses impacts for managing damage and threats to human safety associated with predators in the State to analyze individual and cumulative impacts and to provide a thorough analysis.

In terms of considering cumulative effects, one EA analyzing impacts for the entire State would provide a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. If WS and the ODAFF made a determination through this EA that the alternatives could have a significant impact on the quality of the human environment, then WS and the ODAFF would publish a notice of intent to prepare an EIS and this EA would be the foundation for developing the EIS. Based on previous requests for assistance, the WS program in Oklahoma would continue to conduct predator damage management on a small percentage of the land area in the State where damage was occurring or likely to occur.

A Site Specific Analysis Should be made for Every Location Where Predator Damage Management Would Occur

The underlying intent for preparing an EA is to determine if a proposed action might have a significant impact on the human environment. The EA development process is issue driven, meaning issues that were raised during the interdisciplinary process and through public involvement that were substantive, would be used to drive the analysis and determine the significance of the environmental impacts of the alternatives. Therefore, the level of site specificity must be appropriate to the issues listed.

The issues raised during the scoping process of this EA drove the analysis. In addition to the analysis contained in this EA, WS' personnel use the WS Decision Model (Slate et al. 1992; see WS Directive 2.201) described in Chapter 3 as a site-specific tool to develop the most appropriate strategy at each location. The WS Decision Model is an analytical thought process that WS' personnel would use to evaluate and respond to requests for assistance. As discussed previously, one EA analyzing impacts for the entire State would provide a more comprehensive and less redundant analysis that allows for a better cumulative impact analysis. If a determination were made through this EA that the alternatives developed to meet the need for action could result in a significant impact on the quality of the human environment, then an EIS would be prepared.

Concerns that Killing Wildlife Represents "*Irreparable Harm*"

Public comments have raised the concern that the killing of any wildlife represents irreparable harm. Although the WS program may lethally remove an individual predator or multiple predators in a specific area under some of the alternatives to alleviate damage or threats of damage, the lethal removal of an individual predator or multiple predators in a localized area would not likely represent irreparable harm to the continued existence of a species. Wildlife populations experience mortality from a variety of causes, including human harvest and damage management activities (see Section 4.2). The WS program would conduct damage management activities associated with predators only at the request of a cooperator to reduce damage that was occurring or to prevent damage from occurring. The WS program would monitor activities to ensure the program identified and addressed any potential impacts. WS would work closely with resource agencies to ensure damage management activities would not adversely affect predator populations and that activities conducted by WS were considered as part of management goals established by those agencies. Chapter 4 addresses the environmental consequences that each alternative could have on target predator populations.

Alternatives May Be "*Highly Controversial*" and the Effects May Be "*Highly Uncertain*"

The failure of any particular special interest group to agree with every act of a federal agency does not create a controversy, and the NEPA does not require the courts to resolve disagreements among various scientists as to the methodology used by an agency to carry out its mission (*Marsh vs. Oregon Natural Resource Council*, 490 USC 360, 378 (1989)). Section 4.1 of this EA analyzes the environmental consequences of each alternative in comparison to determine the extent of actual or potential impacts on the issues. If WS made a determination through this EA that the effects were highly uncertain, then the WS would publish a notice of intent to prepare an EIS and this EA would be the foundation for developing the EIS.

Predator Damage Management Should Not Occur at Taxpayer Expense

An issue identified is the concern that WS should not provide assistance at the expense of the taxpayer or that activities should be fee-based. Funding for WS' activities could occur from federal appropriations, through state funding, and through cooperative funding. Funding for WS' activities could occur through cooperative service agreements with individual property owners or managers. Federal, state, and local officials have made the decision to provide funding for damage management activities and have allocated funds for such activities. Additionally, damage management activities are an appropriate sphere of activity for government programs, since managing wildlife is a government responsibility. Treves and Naughton-Treves (2005) and the International Association of Fish and Wildlife Agencies (2005) discuss the need for wildlife damage management and that an accountable government agency is best suited to take the lead in such activities because it increases the tolerance for wildlife by those people being impacted by their damage and has the least impacts on wildlife overall.

Livestock Losses Are a Tax "*Write Off*"

Some people believe that livestock producers receive double benefits because producers could receive assistance from WS to resolve predation on livestock while they also receive deductions for livestock lost as a business expense on tax returns. However, this notion is incorrect because the Internal Revenue Service tax code (Internal Revenue Code, Section 1245, 1281) does not allow livestock losses to be "*written off*" if the killed livestock was produced on their property. Most predation occurs on young livestock (*e.g.*, lambs, kids, and calves) in Oklahoma. Additionally, livestock producers add many ewes, nannies, and cows as breeding stock replacements to herds from the lamb, kid, and calf crop, and if lost to predation they cannot be "*written off*" since the livestock producer did not purchase those animals. Those factors limit the ability of livestock producers to recover financial losses.

Cost Effectiveness of Management Methods

The CEQ does not require a formal, monetized cost benefit analysis to comply with the NEPA. Consideration of this issue is not essential to making a reasoned choice among the alternative approaches that WS and the ODAFF are considering. However, the methods determined to be most effective to reduce damage and threats to human safety caused by predators and that prove to be the most cost effective would likely receive the greatest application. As part of an integrated approach and as part of the WS Decision Model, evaluation of methods would continually occur to allow for those methods that were most effective at resolving damage or threats to be employed under similar circumstance where predators were causing damage or posing a threat. Additionally, management operations may be constrained by cooperator funding and/or objectives and needs. Therefore, the cost of methods can often influence the availability of methods to resolve damage, which can influence the effectiveness of methods.

Effectiveness of Predator Damage Management Methods

Defining the effectiveness of any damage management activities often occurs in terms of losses or risks potentially reduced or prevented. Effectiveness can also be dependent upon how accurately practitioners diagnose the problem, the species responsible for the damage, and how people implement actions to correct or mitigate risks or damages. To determine that effectiveness, WS must be able to complete management actions expeditiously to minimize harm to non-target animals and the environment, while at the same time, using methods as humanely as possible. The most effective approach to resolving any wildlife damage problem would be to use an adaptive integrated approach, which may call for the use of several management methods simultaneously or sequentially.

The purpose behind integrated 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[9]. Efficacy is based on the types of methods employed, the application of the method, restrictions on the use of the method(s), the skill of the personnel using the method and, for WS' personnel, the guidance provided by WS' directives and policies.

The goal would be to reduce damage, risks, and conflicts with wildlife as requested and not to reduce/eliminate populations. Localized population reduction could be short-term with new individuals immigrating into the area or born to animals remaining at the site. The ability of an animal population to sustain a certain level of removal and to return to pre-management levels eventually does not mean individual management actions were unsuccessful, but that periodic management may be necessary. The return of wildlife to pre-management levels also demonstrates that limited, localized damage management methods have minimal impacts on species' populations.

WS often receives comments that lethal methods would be ineffective because additional predators would likely return to the area. In addition, comments also claim that because predators return to an area after initial removal efforts were complete, the use of lethal methods gives the impression of creating a financial incentive to continue the use of only lethal methods. Those statements assume predators only return to an area where damage was occurring if WS or other entities used lethal methods. However, the use of non-lethal methods would also often be temporary, which could result in predators returning to an area where damage was occurring once WS or other entities no longer used those methods. The common factor when employing any method would be that predators would return if suitable conditions continued to exist at the location where damage was occurring and predator densities were sufficient to occupy all available habitats to the extent that damage occurs. Therefore, any reduction or prevention of damage from the use of methods addressed in Appendix B would be temporary if conditions continue to exist that attract predators to an area where damage was occurring.

Dispersing predators using non-lethal methods addressed in Appendix B often requires repeated application to discourage those animals from returning to locations, which increases costs, moves animals to other areas where they could cause damage, and would be temporary if habitat conditions that attracted those predators to damage areas remained unchanged. Some people could view dispersing and translocating predators as moving a problem from one area to another, which would require addressing damage caused by those predators at another location, which can increase costs and could be perceived as creating a financial incentive to continue the use of those methods since predators would have to be addressed annually and at multiple locations. WS' recommendation of or use of techniques to modify existing habitat or making areas unattractive to predators is discussed in Appendix B. WS' objective would be to respond to requests for assistance with the most effective methods and to provide for the long-term solution to the problem using WS' Decision Model.

Managing damage caused by predators can be divided into short-term redistribution approaches and long-term population and habitat management approaches. Short-term approaches focus on redistribution and dispersal of predators to limit use of an area where damage or threats were occurring. Short-term redistribution approaches may include prohibiting feeding, the use of pyrotechnics, propane cannons, effigies, and other adverse noise, erecting access barriers, such as fencing, and repellents. Population reduction by limiting survival or reproduction and habitat modification would be considered long-term solutions to managing damage caused by wildlife.

---

[9] The cost of management may sometimes be secondary because of overriding environmental, legal, human health and safety, animal welfare, or other concerns.

Redistribution methods would often be employed to provide immediate resolution to damage occurring until long-term approaches can be implemented or have had time to reach the desired result. Dispersing predators can often be a short-term solution that moves those predators to other areas where damages or threats could occur. Some short-term methods may become less effective in resolving damage as a predator population increases, as predators become more acclimated to human activity, and as predators become habituated to harassment techniques. Non-lethal methods often require a constant presence at locations when predators were present and must be repeated every day or night until the desired results are achieved, which can increase the costs associated with those activities. Non-lethal methods may also require constant monitoring and maintenance to insure proper results. For example, fencing could be used to prevent access to a resource; however, constant monitoring of the fencing would be required and necessary repairs completed to ensure the use of fencing would be successful in preventing access to resources. Long-term solutions to resolving predator damage often require management of the population and identifying the habitat characteristics that attract predators to a particular location.

Research has shown that in areas without some level of damage management, losses of adult sheep and lambs to predators can be as high as 8.4% and 29.3% of the total number of sheep, respectively (Henne 1975, Munoz 1977, O'Gara et al. 1983). Additional research has indicated that sheep and lamb losses are generally lower where predator damage management was applied (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Howard and Booth 1981). The effectiveness of damage management activities can also be measured by public satisfaction.

Shwiff and Merrell (2004) reported a 5.4% increases in the numbers of calves brought to market when coyotes were removed by aerial operations. Bodenchuk et al. (2002) reported benefit-cost ratios of 3:1 to 27:1 for agricultural resource protection from predators. Wagner and Conover (1999) found that total lamb losses declined 25% on grazing allotments in which coyotes were removed by winter aerial operations five to six months ahead of summer sheep grazing. On allotments where no aerial operations occurred, total lamb losses only declined 6%. Confirmed losses to coyotes declined by 7% on allotments where aerial operation occurred, but increased 35% on allotments where no aerial operations occurred (Wagner and Conover 1999).

Based on an evaluation of the damage situation using the WS Decision Model, the most effective methods could be employed individually or in combination based on prior evaluations of methods or combinations of methods in other damage management situations. Once employed, methods could be further evaluated for effectiveness based on a continuous evaluation of activities by the WS program. Therefore, the effectiveness of methods would be considered as part of the decision-making process under the use of the Decision Model described in Chapter 3 for each damage management request based on the continual evaluation of methods and results.

Livestock Losses are Low When Compared to Losses from Other Sources and Other Factors

As shown in reports published by the NASS and other agencies (*e.g.*, see NASS 2010, NASS 2011, APHIS Veterinary Services 2012, APHIS Veterinary Services 2015, APHIS Veterinary Services 2017), livestock losses do occur from predators but can also occur from disease, weather, injury, birthing, poisoning, and theft. In most cases, livestock losses to non-predator causes are higher than losses attributed to predators. For example, during 2014, the percentage of the lamb crop lost to non-predator causes was 11.3% in Oklahoma. In comparison, the percentage of the lamb crop lost in the State from predators was 5.4% during 2014 (APHIS Veterinary Services 2015). Therefore, people express concern that WS should not provide any assistance or should limit assistance to certain methods (*e.g.,* non-lethal only methods) when livestock losses are low compared to the losses from other sources.

As discussed in Section 1.2, predators are responsible for preying upon a wide variety of livestock, including cattle, sheep, goats, swine, exotic pen-raised game, other hoofed-stock, and poultry. Livestock losses due to predation can cause economic hardships to farmers and ranchers, and without effective ways to reduce predation rates, economic losses from predation can increase (Nass 1977, Howard and Shaw 1978, Nass 1980, Howard and Booth 1981, O'Gara et al. 1983, Bodenchuk et al. 2002). Not all producers suffer losses to predators; however, for those producers that do suffer livestock losses caused by predators, those losses can be economically burdensome (Baker et al. 2008).

The WS program in Oklahoma, along with other entities, has conducted activities to manage damage caused by predators in the State for many years. Therefore, livestock losses in Oklahoma reported by the NASS and other entities are the losses that occur with WS, and other entities, providing assistance with managing predator damage in the State. Thus, the WS program expects livestock losses to be low in the State due to ongoing activities to manage damage. Furthermore, livestock producers generally do not wait for losses to become economically burdensome before conducting damage management activities and/or requesting assistance from WS or other entities. Therefore, livestock producers often attempt to act before such losses become unacceptable. In areas without some level of managing predator damage, losses of adult sheep and lambs can be as high as 8.4% and 29.3%, respectively (Henne 1975, Munoz 1977, O'Gara et al. 1983). Sheep and lamb losses can be lower where people conduct activities to manage predator damage (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Howard and Booth 1981). In addition, while the livestock losses across an entire state in any one year may not represent a large percent of the state's total livestock revenues, livestock losses due to predators can be site-specific and can be economically burdensome for an individual producer.

Section 1.2 discusses the need for action, including the need to manage damage to livestock associated with predators. Based on the information presented in Section 1.2 and for those reasons discussed in this section, the WS program in Oklahoma believes there is a sufficient need to manage the damage that predators can cause to livestock in the State. Section 3.1 and Section 3.2 discuss the alternative approaches that WS identified to manage predator damage in the State, including damage to livestock.

Perceived Threats of Loss Are Not Sufficient to Trigger the Need to Manage Predator Damage

Some people express a concern that individual perceptions of risk from predators could be disproportionately high to actual risk, which could potentially result in a request to have a predator lethally removed just because someone saw the animal near their neighborhood, their business, or their animals. The primary concern is that WS may initiate activities in response to a perceived but unsubstantiated threat from a requester and that perceived threats of loss are not sufficient to trigger the need to manage predator damage.

Section 1.2 addresses the need for action associated with predators in the State, including the threats that predators can pose. For example, as discussed in Section 1.2, aircraft have struck predators in the State, which can cause damage to aircraft and threaten the safety of passengers. Therefore, threats to human safety would likely warrant conducting activities to prevent aircraft from striking predators. Similarly, the spread of diseases or potential attacks on people or pets could warrant activities occurring before a disease outbreak occurs or before a predator seriously injures a person or pet.

As discussed in Section 1.2, a positive correlation between predator concentrations and livestock losses due to predation often exists (Shelton and Klindt 1974, Pearson and Caroline 1981, Nunley 1995, Stoddart et al. 2001). For example, Shelton and Klindt (1974) documented a correlation between coyote densities and levels of sheep loss in Texas, and Robel et al. (1981) found a similar correlation in Kansas. Therefore, when predator concentrations increase, predation loss can be a factor in livestock production; thus, lowering predator densities can reduce predation risks. For example, Gantz (1990) concluded that late winter removal of territorial coyotes from mountain grazing allotments could reduce predation on sheep grazing on those allotments the following summer. Wagner and Conover (1999) found that the percentage of lambs lost to coyote predation declined from 2.8% to less than 1% on grazing allotments in which removal of coyotes occurred three to six months before summer sheep grazing.

The rationale for conducting preventive damage management to reduce damage differs little in principle from holding controlled hunts for deer in certain areas where agricultural damage has been a historic problem. By reducing the number of deer near agricultural fields, or the number of coyotes near a flock of sheep, an entity can reduce the likelihood of damage.

Based on the information presented in Section 1.2 and for those reasons discussed in this section, the WS program in Oklahoma believes there is a sufficient need to manage the threat of damage that predators can pose when WS' personnel use the WS Decision Model to determine that conducting activities to manage those threats would be appropriate. The WS Decision Model (see WS Directive 2.201) described by Slate et al. (1992) depicts how WS' personnel would use a thought process for evaluating and responding to requests for assistance when implementing the applicable alternative approaches discussed in Section 3.1. If an assistance request were within the authority of WS, WS' employees would gather and analyze damage information 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' employees could gather and analyze would include the current economic loss or current threat (*e.g.*, threat to human safety), the potential for future losses or damage, the local history of damage, and what management methods, if any, were used to reduce past damage and the results of those actions. In addition, under several alternative approaches identified in Section 3.1, WS' personnel could provide technical assistance (*e.g.*, advice, training, educational materials) to individuals and communities so they have the information needed to better understand the role and potential impacts of animals in their area.

Rancher Responsibility to Protect their Livestock through Use of Husbandry Methods

As discussed in Section 1.2 and elsewhere in the EA, livestock producers in Oklahoma do implement many non-lethal methods to prevent livestock predation. The primary non-lethal method employed by cattle producers in Oklahoma was the use of guard animals. WS was instrumental in the introduction and adoption of livestock guarding dogs in the late 1980s and early 1990s and continues to recommend use of livestock guarding dogs where appropriate (Green and Woodruff 1983, Green and Woodruff 1988). The NWRC continues to conduct research into new breeds of livestock guarding dogs (Marlow 2016). Producers also reported using additional non-lethal methods, including culling, frequent checks, livestock carcass removal, exclusion fencing, fright tactics, herding, and night penning (NASS 2011). Sheep producers in the State use many of the same non-lethal methods, with guard animals being a primary method (APHIS Veterinary Services 2015).

Some non-lethal methods available to alleviate damage or threats associated with predators are impractical for implementation by WS' personnel, such as altering livestock management practices (*e.g.*, night-penning, herding, carcass removal) and physical exclusion (*e.g.*, predator-proof fencing). Therefore, implementation of most non-lethal methods for livestock protection falls within the purview of the livestock producer (Knowlton et al. 1999). Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. Many of those non-lethal methods (*e.g.*, fencing and guard animals) require a large investment in time to implement and have a high initial cost (Mitchell et al. 2004). Even with the additional effort and costs, those methods are not always effective at reducing damage and potentially have side effects (*e.g.*, concentrating livestock can cause unwanted damage to particular pasture areas) (Knowlton et al. 1999).

If WS implemented several of the alternative approaches discussed in Section 3.1, WS' personnel would use the WS Decision Model to evaluate and respond to requests for assistance, which would include assessing what management methods, if any, the requester was using to reduce damage and the results of those actions. Based on that assessment, WS could recommend or implement non-lethal methods to alleviate damage if WS implements several of the alternative approaches discussed in Section 3.1. In addition, pursuant to WS Directive 2.101, WS' personnel would give preference to non-lethal methods when they determine those methods to be practical and effective for the damage situation.

Impacts of WS' Activities on the Use of Public Areas by People

The use of public areas by people can encompass a wide variety of outdoor activities in the form of consumptive and non-consumptive uses and provides aesthetic benefits to the individuals who participate in the activities. In addition, those activities can contribute the economy in Oklahoma. Examples of consumptive uses of public lands include hunting and fishing. Examples of non-consumptive uses include bird watching, photography, camping, hiking, and biking.

The State of Oklahoma encompasses approximately 43.9 million acres of land (United States Census Bureau 2010). In Oklahoma, there are approximately 701,400 acres of federal property (Vincent et al. 2014). However, not all of the federal property in the State is open to public access. The ODWC manages more than 1.6 million acres in the State for hunters and anglers (ODWC 2015). In addition, the Commissioners of the Land Office (2015) have administrative authority over approximately 750,000 acres of state trust land. In total, less than 7% of the land area within the State is public land. In addition, not all of the public land is open to public access.

If the WS program in Oklahoma conducts activities on public lands, some people occasionally express concerns that WS' activities would limit their ability to use those areas or would increase threats to the safety of people and pets from the potential exposure of the public to methods that WS could use on those lands. The potential risks to human health and safety associated with WS' use of the methods discussed in Appendix B is a concern that WS identifies in Section 2.2 and evaluates in comparison amongst the alternatives in Section 4.1. Similarly, Section 2.2 and Section 4.1 address the potential effects from WS' activities on the public's aesthetic enjoyment of animals and the potential effects of WS' activities on recreational activities (*e.g.*, hunting, wildlife watching, hiking).

As discussed further in Section 3.1, the WS program would only conduct activities when the appropriate landowner or manager requests such assistance and only after the landowner or manager signs a MOU, work initiation document, work plan, or a similar document allowing WS to conduct activities. On public lands, the WS program in Oklahoma would coordinate with the land management agency to determine high public use areas, which could include the use of areas during particular times of the year, such as during a hunting season. In most cases, WS avoids conducting activities in high use recreational areas on public lands. An exception could be a situation where WS receives a request to assist with threats to human health and safety in those areas. In addition, WS' personnel and/or the management agency would likely limit the types of equipment that WS would use in those areas. For example, the WS program in Oklahoma could coordinate with land management agencies by developing a work plan. As part of the work plan, the land management agency could designate different work zones on maps that they provide to WS. If the land management agency designated a particular work zone as a high use recreational area, the agency could limit the use of certain methods to a quarter of a mile of those areas. In another example, if a particular area is a high use area during certain times of the year, such as during a hunting season, the work plan could require the removal of all methods from those areas during the duration of the hunting season. Therefore, the land management agency and WS can identify high use recreational areas in work plans and on maps so WS' activities do not interfere with recreational activities unless necessary (*e.g.*, to protect human health and safety).

In addition, public land management agencies do not generally close public land areas while WS' personnel conduct activities or because of WS' activities, except in extreme cases where threats to human health or safety was a concern. For example, if a predator attacked a visitor, the land management agency could close an area where the attack occurred to reduce risks to other visitors until WS was able to capture or remove the responsible animal. In those cases, the land management agency would likely restrict access to an area because of the threat to human safety associated with an animal or animals and not because of specific activities that WS would conduct. In those situations, the land management agency would likely close the area in the absence of any involvement by WS.

Therefore, the activities of WS are not likely to limit or restrict access to public lands within the State. A land management agency would determine what, if any, restrictions would occur on lands they own or manage. Coordination of WS' activities with the land management agency would ensure restrictions or access limitations were not necessary by avoiding high use areas. Section 4.1 of this EA evaluates the potential threats to human health and safety associated with the alternative approaches to managing predator damage in the State. Similarly, Section 4.1 addresses the potential effects from WS' activities on the public's aesthetic enjoyment of animals and the potential effects of WS' activities on recreational activities.

Impacts on Cultural, Archaeological, and Historic Resources, and Tribal Cultural Properties

The methods described in this EA that WS could use to manage predator damage do not cause major ground disturbance, do not cause any physical destruction or damage to property, do not cause any alterations of property, wildlife habitat, or landscapes, and do not involve the sale, lease, or transfer of ownership of any property. In general, the use of such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas that could result in effects on the character or use of historic properties. Therefore, the methods that would be available under the alternatives would not generally be the types of methods that would have the potential to affect historic properties. If WS planned an individual activity with the potential to affect historic resources under an alternative selected because of a decision on this EA, WS would conduct the site-specific consultation, as required by Section 106 of the NHPA, as necessary.

The use of noise-making methods, such as firearms, at or in close proximity to historic or cultural sites for the purposes of removing predators have the potential for audible effects on the use and enjoyment of historic property. However, WS would only use such methods at a historic site at the request of the owner or manager of the site to resolve a damage problem, which means such use, would be to the benefit of the historic property. A built-in minimization factor for this issue is that virtually all the methods involved would only have temporary effects on the audible nature of a site and could be ended at any time to restore the audible qualities of such sites to their original condition with no further adverse effects. WS would conduct site-specific consultation as required by the Section 106 of the NHPA, as necessary, in those types of situations. The Oklahoma Historic Preservation Office has indicated no concerns with actions conducted by WS in the State.

In addition, the WS program in Oklahoma would only conduct activities on tribal lands at the request of the tribe and only after signing appropriate authorizing documents. Therefore, the Tribe would determine what activities they would allow and when WS' assistance was required. Because Tribal officials would be responsible for requesting assistance from WS and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would likely occur.

Effects of Activities on Unique Characteristics of Geographic Areas

A number of different types of federal and state lands occur within the analysis area, such as national wildlife refuges, waterfowl production areas, wildlife management areas, and national grasslands. WS recognizes that some persons interested in those areas may feel that any activities would adversely affect the aesthetic value and natural qualities of the area. WS would abide by federal and state laws, regulations, work plans, MOUs, and policies to minimize any effect on the public and would abide by any restrictions imposed by the land management agency on activities conducted by WS.

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

A concern identified is the potential effects of damage management activities on wildlife species when considering past, present, and future effects from other activities, such as oil and gas development, timber harvesting, other land development actions, such as residential subdivision development, and grazing. WS has no authority to affect decisions of other entities that engage in or approve such actions. Thus, the decisions made by other entities do not relate or connect to activities that WS could conduct. The effects of such actions by other agencies and entities are part of the existing *environmental status quo* and would neither increase nor decrease because of activities that could be conducted by WS.

The following discussion is provided to give an example of what potential, if any, damage management activities conducted by WS could contribute to cumulative effects on wildlife species in Oklahoma and the environment that have resulted from oil and gas development, timber harvest, land development, and grazing (*i.e.*, the environmental baseline).

Adverse effects on some wildlife could result from land management and development activities. Housing developments in rural areas can potentially have adverse effects on wildlife by diminishing habitat (Gill 1999). Oil and gas development can adversely affect certain wildlife species by reducing the amount of available habitat. Road building and establishment of well pads (sites where wells are drilled to pump oil or gas out of the ground) reduce habitat directly by removing vegetation that animals use for food and cover. Timber harvest can benefit some wildlife species while negatively affecting others (United States Forest Service 2003). For example, deer generally benefit from the creation of openings in large expanses of mature forest. Roads established to support oil and gas development and timber harvest further indirectly reduce the amount of habitat effectively available to certain species because many of those species fear using areas where humans are traveling, which is considered a displacement effect caused by roads.

If the WS program selected an alternative approach to meeting the need for action that allows the program in Oklahoma to provide assistance (see Section 3.1), WS would monitor activities, in context of the issues analyzed in detail, to determine if the need for action and the associated impacts remain with the parameters established and analyzed in this EA. Pursuant to SOPs discussed in Section 3.3 and Section 3.4, WS would continue to coordinate activities to reduce and/or prevent predator damage in the State with the ODWC. The ODWC is responsible for managing wildlife populations in the State and their habitats. Therefore, coordinating activities would ensure the ODWC had the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the State. As part of those coordinated activities, WS would submit annual activity reports to the ODWC to aid with the ongoing monitoring efforts of the ODWC. If WS and the ODWC determined that new needs for action, changed conditions, new issues, or new alternatives having different environmental impacts must be analyzed, WS and the ODAFF would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS and the ODAFF can evaluate and adjust activities as changes occur over time.

WS' monitoring would also include reviewing the list of species the USFWS considers as threatened or endangered within the State pursuant to the ESA. As appropriate, WS would consult with the USFWS pursuant to Section 7 of the ESA to ensure the activities conducted by WS would not jeopardize the continued existence of threatened or endangered species or result in adverse modification to areas designated as critical habitat for a species within the State. Through the review of species listed as threatened or endangered and the consultation process with the USFWS, the WS program in Oklahoma can evaluate and adjust activities conducted pursuant to any alternative approach selected to meet the need for action. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review and consultation process. In this way, any actions conducted by WS would be responsive to ongoing changes and the associated cumulative impacts of actions conducted in Oklahoma in accordance with the NEPA.

Effects of Livestock Grazing on Riparian Areas and Wildlife Habitat as a Connected Action to Damage Management Activities

Based on other scoping process, some members of the public have expressed that livestock grazing is a connected action to damage management activities. However, a connected action implies that grazing is an interdependent part of damage management activities that depends on such activities for its justification, that it is automatically triggered by damage management activities, or that grazing cannot and will not proceed unless damage management occurs (40 CFR 1508.25).

Livestock grazing in Oklahoma occurs on private property at the discretion of the property owner without involvement from WS or any activities conducted by WS. Therefore, livestock grazing is not automatically triggered by damage management activities conducted by WS, and it clearly can and does proceed in the absence of damage management assistance provided by WS.

Some public commenters have asserted that damage management activities to protect livestock cannot or would not proceed unless livestock grazing was occurring. If no livestock production occurred, there would be no need to protect livestock from predation and there would be no reason for WS to conduct damage management for livestock protection if there were no livestock. Conversely, there would be no damage management actions to protect livestock if there were no predators. Damage management activities associated with predators could and do occur by other entities in Oklahoma, whether WS provides such assistance or not. Since federal agencies do not have the authority to regulate private land livestock grazing, such grazing and its effects are part of the existing human environment (*i.e.*, environmental status quo) and such private land livestock grazing is quite common and extensive.

As long as livestock producers experience economic losses from predators, activities to prevent or reduce further losses would continue to occur whether assistance was provided by WS or not. In the absence of any involvement by WS, livestock owners and managers or authorized state agencies would continue to conduct damage management activities on their own. Even if some livestock producers went out of business due to economically severe predation in the absence of any assistance that does not mean livestock grazing would not continue. Some of those producers would be expected to sell their properties to other producers that may have a better economic ability to withstand predation losses.

Livestock grazing and its impacts on the environment and damage management activities conducted by non-federal entities does not have to comply with the requirements and provisions of the NEPA and would represent the environmental status quo for the human environment. Damage management activities by private or non-federal entities would not be governed or restricted by the environmental laws that govern federal agencies, such as the NEPA and the consultation requirements of Section 7 of the ESA. The only livestock grazing activities that are subject to the requirements of the NEPA would be those that were authorized by federal land management agencies to occur on federal lands, such as the BLM or United States Forest Service. Those federal agencies would prepare documents pursuant to the NEPA covering their authorization of livestock grazing on federal public lands and the potential environmental effects of livestock grazing.

Effects of Activities on Soils, Water, and Air Quality

The implementation of those alternative approaches discussed in Section 3.1 by WS would meet the requirements of applicable federal laws, regulations, and Executive Orders for the protection of the environment, including the Clean Air Act and Executive Order 13514[10]. The actions discussed in this EA do not involve major ground disturbance, construction, or habitat alteration. Chapter 3 discusses the SOPs to reduce risks to the environment that WS would incorporate into activities when implementing applicable alternative approaches to managing damage. Activities that WS could implement pursuant to those applicable alternative approaches discussed in Section 3.1 would not occur in aquatic systems or cause changes in the flow, quantity, or storage of water resources. WS' personnel would use, store, and dispose of all chemical methods in accordance with applicable laws and regulations pursuant to WS Directive 2.210. The use, storage, and disposal of chemical methods by WS' personnel would also follow WS' directives, including WS Directive 2.401, WS Directive 2.405, WS Directive 2.415, WS Directive 2.430, WS Directive 2.455, and WS Directive 2.465.

WS' personnel would follow EPA-approved label directions for all pesticide use (see WS Directive 2.401). The intent of the registration process for chemical pesticides is to assure minimal adverse effects occur to the environment when people use the chemicals in accordance with label directions. For example, the EPA (2009) determined there was no risk of exposure through soil or surface water when following the label restrictions for sodium cyanide in the M-44 device. The WS program in Oklahoma would properly dispose of any excess solid or hazardous waste in accordance with applicable federal, tribal, state, and local regulations.

Aerial wildlife operations, like any other flying, may result in an accident. WS' pilots and crewmembers would receive training and would have experience to recognize the circumstances that lead to accidents. The national WS Aviation Program has increased its emphasis on safety, including funding for additional training, the establishment of a WS Flight Training Center, and annual recurring training for all pilots. However, accidents may still occur. Nationwide, the WS program has been using aircraft during aerial operations for many years. During this time, no incidents of major ground fires associated with WS' aircraft accidents have occurred.

Aviation fuel is extremely volatile and it will normally evaporate within a few hours or less to the point that even detecting its odor is difficult. The fuel capacity for aircraft used by WS varies. For fixed-winged aircraft, a 52-gallon capacity would generally be the maximum, while 91 gallons would generally be the maximum fuel capacity for helicopters. In some cases, little or none of the fuel would spill if an accident occurs. Thus, there should be little environmental hazard from unignited fuel spills.

With the size of aircraft used by WS, the quantities of oil (*e.g.*, 6 to 8 quarts maximum for reciprocating (piston) engines and 3 to 5 quarts for turbine engines) capable of spilling in any accident would be small with minimal chance of causing environmental damage. Aircraft used by WS would be single engine models, so the greatest amount of oil that could spill in one accident would be about eight quarts.

---

[10]Executive Order 13514 mandates that at least 15 percent of existing federal buildings and leases meet Energy Efficiency Guiding Principles by 2015, and that annual progress be made toward 100 percent conformance of all federal buildings, with a goal of 100% of all new federal buildings achieving zero-net-energy by 2030. "*Zero-net-energy building*" is defined in Executive Order 13514 as "*a building that is designed, constructed, and operated to require a greatly reduced quantity of energy to operate, meet the balance of energy needs from sources of energy that do not produce greenhouse gases, and therefore result in no net emissions of greenhouse gases and be economically viable*".

Petroleum products degrade through volatilization and bacterial action, particularly when exposed to oxygen (EPA 2000). Thus, small quantity oil spills on surface soils can biodegrade readily. Even in subsurface contamination situations involving underground storage facilities that generally involve larger quantities than would ever be involved in a small aircraft accident, the EPA guidelines provide for *"natural attenuation"* or volatilization and biodegradation in some situations to mitigate environmental hazards (EPA 2000). Thus, even where the owner of the aircraft did not clean up oil spills in small aircraft accidents, the oil does not persist in the environment or persists in such small quantities that no adverse effects would likely occur. In addition, WS' accidents generally would occur in remote areas away from human habitation and drinking water supplies. Thus, the risk to drinking water appears to be exceedingly low to nonexistent.

For those reasons, the risk of ground fires or fuel/oil pollution from aviation accidents would be low. In addition, based on the history and experience of the program in aircraft accidents, it appears the risk of significant environmental damage from such accidents is exceedingly low.

Consequently, the WS program in Oklahoma does not expect the alternative approaches discussed in Section 3.1 to significantly impact soils, geology, minerals, water quality and quantity, floodplains, wetlands, other aquatic resources, air quality, prime and unique farmlands, timber, and range. Therefore, the EA will not analyze those elements further.

Effects from the Use of Lead Ammunition in Firearms

Questions have arisen about the deposition of lead into the environment from ammunition used in firearms to remove predators. As described in Appendix B, the lethal removal of predators with firearms by WS to alleviate damage or threats could occur using a handgun, rifle, or shotgun. In an ecological risk assessment of lead shot exposure in non-waterfowl birds, ingestion of lead shot was identified as the concern rather than just contact with lead shot or lead leaching from shot in the environment (Kendall et al. 1996).

The removal of predators by WS using firearms in the State would occur primarily from the use of shotguns and rifles. However, WS' personnel could employ the use of handguns to euthanize predators. To reduce risks to human safety and property damage from bullets passing through predators, the use of firearms would be applied in such a way (*e.g.*, caliber, bullet weight, distance) to ensure the bullet does not pass through predators. Predators that were removed using firearms would occur within areas where retrieval of predator carcasses for proper disposal is highly likely (*e.g.*, at an airport). With risks of lead exposure occurring primarily from ingestion of bullet fragments, the retrieval and proper disposal of animal carcasses would greatly reduce the risk of scavengers ingesting lead that carcasses may contain.

However, deposition of lead into soil could occur if, during the use of a firearm, the projectile passed through a predator, if misses occurred, or if the retrieval of the carcass did not occur. 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 generally stays within the top 20 cm (about 8 inches). In addition, concerns occur that lead from bullets deposited in soil from shooting activities could contaminate ground water or surface water from runoff. Stansley et al. (1992) studied lead levels in water subject to high concentrations of lead shot accumulation because of intensive target shooting at several shooting ranges. Lead did not appear to "*transport*" readily in surface water when soils were neutral or slightly alkaline in pH (*i.e.*, not acidic), but lead did transport more readily under slightly acidic conditions. Although Stansley et al. (1992) detected elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at a shooting range, the study did not find higher lead levels in a lake into which the stream drained, except for one sample collected near a parking lot. Stansley et al. (1992) believed the lead contamination near the parking lot was due to runoff from the lot, and not from the shooting range areas. The study also indicated that even when lead shot was highly accumulated in areas with permanent water bodies present, the lead did not necessarily cause elevated lead levels in water further downstream. Muscle samples from two species of fish collected in water bodies with high lead shot accumulations had lead levels that were well below the accepted threshold standard of safety for human consumption (Stansley et al. 1992).

Craig et al. (1999) reported that lead levels in water draining away from a shooting range with high accumulations of lead bullets in the soil around the impact areas were far below the "*action level*" of 15 parts per billion as defined by the EPA (*i.e.*, requiring action to treat the water to remove lead). The study found that the dissolution (*i.e*., capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments (Craig et al. 1999). Therefore, the lead oxide deposits that form on the surface of bullets and shot serves to reduce the potential for ground or surface water contamination (Craig et al. 1999). Those studies suggest that, given the very low amount of lead that WS could deposit and the concentrations that would occur from WS' activities to reduce predator damage using firearms, as well as most other forms of dry land small game hunting in general, lead contamination of water from such sources would be minimal to nonexistent.

Since those predators removed by WS using firearms could be lethally removed by the entities experiencing damage using the same method in the absence of WS' involvement, WS' assistance with removing those predators would not be additive to the environmental status quo. The proficiency training received by WS' employees in firearm use and accuracy would increase the likelihood that predators were lethally removed humanely in situations that ensure accuracy and that misses occur infrequently, which further reduces the potential for lead to be deposited in the soil from misses or from projectiles passing through carcasses. Based on current information, the risks associated with lead projectiles that WS could contribute to the environment due to misses, the projectile passing through the carcass, or from carcasses that may be irretrievable would be below any level that would pose any risk from exposure or significant contamination.

Concerns that WS' Employees Might Unknowingly Trespass onto Private Lands or Across State Boundary Lines, Either on the Ground or during Aerial Hunting Activities

WS would only provide direct operational assistance after a work initiation document or a similar document had been signed between WS and the entity or entities requesting such assistance and only on properties the cooperating entity or entities owns or manages. In addition, only those methods agreed upon and included in the work initiation document or a similar document would be employed by WS during direct operational assistance. Prior to conducting direct operational assistance on properties where a work initiation document or a similar document was signed between WS and a cooperating entity, the landowner or manager where the work was to be conducted would provide WS with specific information about property boundaries. Specific information on property boundaries could occur in the form of aerial maps with boundaries marked, the cooperator physically showing a WS' employee the property boundaries, or the cooperator providing a detailed verbal description. In addition, especially where aerial operations have been requested and agreed upon, Global Positioning System coordinates and/or other electronic files for use in navigation electronics could be used to mark property boundaries. Aerial operations also typically involve a ground crew that consists of a WS' employee that is in radio contact with the aircraft who knows the property boundaries of the area. Based on those considerations, the likelihood of a WS' employee conducting activities in areas where those activities had not been requested would be minimal to non-existent.

Influence of Global Climate Change

The State of the Climate in 2012 report indicates that every year has been warmer than the long-term average since 1976 (Blunden and Arndt 2013). Impacts of this change will vary throughout the United States, but some areas could experience air and water temperature increases, alterations in precipitation, and increased severe weather events. Temperature and precipitation often influence the distribution and abundance of a plant or animal species. According to the EPA (2016), as temperatures continue to increase, the ranges of many species will likely expand into northern latitudes and higher altitudes. Species adapted to cold climates may struggle to adjust to changing climate conditions (*e.g.*, less snowfall, range expansions of other species).

The impact of climate change on wildlife and their habitats is of increasing concern to land managers, biologists, and members of the public. Most of the target predator species that WS could address in the State are abundant across a wide range of climate conditions (*e.g*., fox, coyote, raccoon, and skunks) and may be relatively resilient to climatic change. Other species may be less tolerant because of their use of specific habitat types that changing climate conditions could negatively influence. For example, climate change may alter the frequency and severity of habitat-altering events, such as wildfires, weather extremes, such as drought, presence of invasive species, and wildlife diseases. WS recognizes that climate change is an ongoing concern and may result in changes in species range and abundance. Climate change may also affect agricultural practices. Over time, the combination of these two factors is likely to lead to changes in the scope and nature of human-wildlife conflicts in the State. Because these types of changes are an ongoing process, this EA has developed a dynamic system, including SOPs, and built in measures that allow agencies to monitor for and adjust to impacts of ongoing changes in the affected environment (see Section 3.3 and Section 3.4).

If the WS program selected an alternative approach to meeting the need for action that allows the program in Oklahoma to provide assistance (see Section 3.1), WS would monitor activities, in context of the issues analyzed in detail, to determine if the need for action and the associated impacts remain with the parameters established and analyzed in this EA. Pursuant to SOPs discussed in Section 3.3 and Section 3.4, WS would continue to coordinate activities to reduce and/or prevent predator damage in the State with the ODWC. The mission of the ODWC "*…is the management, protection, and enhancement of wildlife resources and habitat for the scientific, educational, recreational, aesthetic, and economic benefits to present and future generations of citizens and visitors to Oklahoma*" (ODWC 2016*a*). Therefore, coordinating activities would ensure the ODWC had the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the State. As part of those coordinated activities, WS would submit activity reports to the ODWC to aid with the ongoing monitoring efforts of the ODWC. If WS and the ODAFF determined that new needs for action, changed conditions, new issues, or new alternatives having different environmental impacts must be analyzed, WS and the ODAFF would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS and the ODAFF can evaluate and adjust activities as changes occur over time.

WS' monitoring would also include reviewing the list of species the USFWS considers as threatened or endangered within the State pursuant to the ESA. As appropriate, WS would consult with the USFWS pursuant to Section 7 of the ESA to ensure the activities conducted by WS would not jeopardize the continued existence of threatened or endangered species or result in adverse modification to areas designated as critical habitat for a species within the State. Through the review of species listed as threatened or endangered and the consultation process with the USFWS, the WS program in Oklahoma can evaluate and adjust activities conducted pursuant to any alternative approach selected to meet the need for action. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review and consultation process. In this way, any actions conducted by WS would be responsive to ongoing climate changes and the associated cumulative impacts of actions conducted in Oklahoma in accordance with the NEPA.

Greenhouse Gas Emissions by the WS Program

Under the alternative approaches intended to meet the need for action discussed in Chapter 3, the WS program in Oklahoma could potentially produce criteria pollutants (*i.e*., pollutants for which maximum allowable emission levels and concentrations are enforced by state agencies). Those activities could include working in the office, travel from office to field locations, travel at field locations (vehicles or ATV), and from aircraft activities. During evaluations of the national program to manage feral swine (*Sus scrofa*), the WS program reviewed greenhouse gas emissions for the entire national WS program (USDA 2015*b*). The analysis estimated effects of vehicle, aircraft, office, and ATV use by WS for FY 2013 and included the potential new vehicle purchases that could be associated with a national program to manage damaged caused by feral swine. The review concluded that the range of Carbon Dioxide Equivalents (includes CO_2, NO_x CO, and SO_x) for the entire national WS program would be below the reference point of 25,000 metric tons per year recommended by CEQ for actions requiring detailed review of impacts on greenhouse gas emissions. The activities that WS could conduct under the alternative approaches discussed in Chapter 3 would have negligible cumulative effects on atmospheric conditions, including the global climate.

CHAPTER 3: ALTERNATIVES

Section 3.1 contains a discussion of the alternatives that WS and the ODAFF developed to meet the need for action discussed in Chapter 1 and to address the identified issues discussed in Chapter 2. WS and the ODAFF developed the alternatives based on the need for action and issues using the WS Decision Model (Slate et al. 1992; see WS Directive 2.201). The alternatives will receive detailed environmental impacts analysis in Chapter 4 (Environmental Consequences). Section 3.2 also discusses alternatives considered but not analyzed in detail, with rationale. In addition, Section 3.3 and Section 3.4 discuss the SOPs that WS would incorporate into the relevant alternatives.

3.1 DESCRIPTION OF THE ALTERNATIVES

WS and the ODAFF developed the following alternatives to meet the need for action and address the identified issues associated with managing damage caused by predators in the State.

Alternative 1 - Continue the Current Adaptive Integrated Methods Approach to Managing Predator Damage (No Action/Proposed Action)

Alternative 1 would continue the current implementation of an adaptive integrated methods approach utilizing non-lethal and lethal techniques when WS receives a request for assistance in Oklahoma[11]. This approach to managing damage associated with predators would integrate the use of the most practical and effective methods to resolve a request for damage management as determined by a site-specific evaluation for each request. WS' personnel would determine the appropriate methods to reduce damage and threats of damage by using the WS Decision Model (see discussion below on the WS Decision Model).

[11] Alternative 1 was identified as the no action alternative and meets the definition of the no action alternative as defined by the CEQ (CEQ 1981). The CEQ has made two distinct interpretations of what constitutes a "*no action*" alternative. One interpretation involves the situation where an ongoing program would continue, even as a new plan is being developed. In those cases, "*no action*" has been interpreted by the CEQ to mean "*no change*" from the current management direction or level of intensity. The "*no action*" alternative is considered a continuation of the present course of action until the action is changed.

A major goal of the program would be to resolve and prevent damage caused by predators and to reduce threats to human safety. To meet this goal, WS would continue to respond to requests for assistance with, at a minimum, technical assistance, or when funding[12] was available, direct operational assistance. WS would provide those entities requesting assistance with information regarding the use of appropriate non-lethal and lethal techniques.

Under this alternative, WS could respond to requests for assistance by: 1) taking no action, if warranted, 2) providing only technical assistance to property owners or managers on actions they could take to reduce damages caused by predators, or 3) providing technical assistance and direct operational assistance to a property owner or manager experiencing damage. To meet the need for action, the objectives of this alternative would be to assist all of the people requesting WS' assistance, within the constraints of available funding and workforce.

WS could provide property owners or managers requesting assistance with information regarding the use of effective and practical non-lethal and lethal techniques. WS would give preference to non-lethal methods when practical and effective under this alternative (see WS Directive 2.101). Property owners or managers may choose to implement WS' recommendations on their own (*i.e.*, technical assistance), use contractual services of private businesses, use volunteer services of private organizations, use the services of WS (*i.e.*, direct operational assistance), take the management action themselves, or take no further action.

WS would work with those persons experiencing predator damage to address those predators responsible for causing damage as expeditiously as possible. To be most effective, damage management activities should occur as soon as predators begin to cause damage. Once predators become familiar with a particular location (*i.e.*, conditioned to an area), dispersing those predators or making the area unattractive can be difficult. WS would work closely with those entities requesting assistance to identify situations where damage could occur and begin to implement damage management activities under this alternative as early as possible to increase the likelihood of those methods achieving the level of damage reduction requested by the cooperating entity.

The WS Decision Model would be the implementing mechanism for a damage management program under Alternative 1 that could be adapted to an individual damage situation. This alternative would allow WS to use the broadest range of methods to address damage or the threat of damage. When WS received a request for direct operational assistance, WS would conduct site visits to assess the damage or threats, would identify the cause of the damage, and would apply the Decision Model described by Slate et al. (1992) and WS Directive 2.201 to determine the appropriate methods to resolve or prevent damage. Discussion of the Decision Model and WS' use of the Model under Alternative 1 occurs below. In addition, WS would give preference to non-lethal methods when practical and effective (see WS Directive 2.101). When receiving requests for assistance associated with feral or free-ranging dogs, the WS program would follow WS Directive 2.340.

Non-lethal methods that would be available for use by WS under this alternative include, but are not limited to minor habitat modification, behavior modification, visual deterrents, live traps, translocation, exclusionary devices, frightening devices, and immobilizing drugs (see Appendix B for a complete list and description of potential methods). Lethal methods that would be available to WS under this alternative include cable devices, the recommendation of harvest during the hunting and/or trapping season, euthanasia chemicals, sodium cyanide (coyotes, fox, feral dogs only), fumigants (coyotes, red fox, striped skunks only), and shooting, including the use of firearms from aircraft. In addition, target

[12]Funding for WS to conduct damage management activities could occur through federal appropriations, state appropriations, or from cooperative funding.

predators live-captured using non-lethal methods (*e.g*., live-traps, immobilizing drugs) could be euthanized. The lethal control of target predators would comply with WS Directive 2.505. The use of sodium cyanide (M-44 devices) to manage damage associated with coyotes, fox, and feral dogs would occur pursuant to WS Directive 2.415. The use of fumigants during denning activities targeting coyotes, red fox, and striped skunks would adhere to WS Directive 2.425.

Discussing methods does not imply that all methods would be used or recommended by WS to resolve requests for assistance and does not imply that all methods would be used to resolve every request for assistance. The most appropriate response would often be a combination of non-lethal and lethal methods, or there could be instances where application of lethal methods alone would be the most appropriate strategy. For example, if an entity requesting assistance had already attempted to alleviate damage using non-lethal methods, WS would not necessarily employ those same non-lethal methods, since the previous use of those methods were ineffective at reducing damage or threats to an acceptable level to the requester.

Many lethal and non-lethal methods are intended to be short-term attempts at reducing damage occurring at the time those methods were employed. Long-term solutions to managing predator damage could include limited habitat manipulations and changes in cultural practices, which are techniques addressed further below and in Appendix B.

Non-lethal methods can disperse or otherwise make an area unattractive to predators causing damage; thereby, reducing the presence of predators at the site and potentially the immediate area around the site where non-lethal methods were employed. WS' personnel would give preference to non-lethal methods when addressing requests for assistance (see WS Directive 2.101). However, WS' personnel would not necessarily employ non-lethal methods to resolve every request for assistance if deemed inappropriate by WS' personnel using the WS Decision Model, especially when the requesting entity had used non-lethal methods previously and found those methods to be inadequate to resolving the damage or threats of damage. WS' employees could use non-lethal methods to exclude, harass, and disperse target predators from areas where damage or threats were occurring. When effective, non-lethal methods would disperse predators from an area resulting in a reduction in the presence of those predators at the site where a person employed those methods. For any management methods employed, the proper timing would be essential in effectively dispersing those predators causing damage. Employing methods soon after damage begins or soon after a property owner or manager identifies threats, increases the likelihood that those damage management activities would achieve success in addressing damage. Therefore, coordination and timing of methods would be necessary to be effective in achieving expedient resolution of predator damage.

Under Alternative 1, WS could employ only non-lethal methods when determined to be appropriate for each request for assistance to alleviate damage or reduce threats of damage using the WS Decision Model. In some situations, a cooperating entity has tried to employ non-lethal methods to resolve damage prior to contacting WS for assistance. In those cases, the methods employed 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 could employ other non-lethal methods, attempt to apply the same non-lethal methods, or employ lethal methods. In many situations, the implementation of non-lethal methods, such as exclusion-type barriers, would be the responsibility of the requester, which means that, in those situations, the only function of WS would be to implement lethal methods, if determined to be appropriate using the WS Decision Model.

WS could employ lethal methods to resolve damage associated with those predators identified by WS as responsible for causing damage or threats to human safety under this alternative; however, WS would only employ lethal methods after receiving a request for the use of those methods. The use of lethal methods could result in local population reductions in the area where damage or threats were occurring since people could remove individual predators from the population. WS and other entities often employ lethal methods to reinforce non-lethal methods and to remove predators that WS or other entities identify as causing damage or posing a threat to human safety. The number of predators removed from the population using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of predators involved with the associated damage or threat, and the efficacy of methods employed.

Often of concern with the use of lethal methods is that predators that were lethally removed would only be replaced by other predators either after the application of those methods (*e.g*., predators that relocate into the area) or by predators the following year (*e.g*., increase in reproduction and survivability that could result from less competition). As stated previously, WS' personnel would not use lethal methods as population management tools over broad areas. The intent of using lethal methods would be to reduce the number of predators present at a specific location where damage was occurring by targeting those predators causing damage or posing threats. The intent of lethal methods would be to manage damage caused by individual predators and not to manage entire predator populations.

Most lethal and non-lethal methods currently available provide only short-term benefits when addressing predator damage. The intended use of those methods would be to reduce damage occurring at the time those methods were employed but do not necessarily ensure predators would not return once those methods were discontinued. Long-term solutions to resolving predator damage would often be difficult to implement and can be costly. In some cases, long-term solutions involve exclusionary devices, such as fencing, or other practices that would not be costly or difficult to implement such as closing garbage cans. When addressing predator damage, long-term solutions generally involve modifying existing habitat or making conditions to be less attractive to predators. To ensure complete success, alternative sites in areas where damage was not likely to occur would often be required to achieve complete success in reducing damage and to avoid moving the problem from one area to another. Modifying a site to be less attractive to predators would likely result in the dispersal of those predators to other areas where damage could occur or could result in multiple occurrences of damage situations.

WS may recommend predators be harvested during the regulated hunting and/or trapping season for those species in an attempt to reduce the number of predators causing damage. Managing predator populations over broad areas could lead to a decrease in the number of predators causing damage. Establishing hunting or trapping seasons and the allowed harvest levels during those seasons is the responsibility of the ODWC. WS does not have the authority to establish hunting or trapping seasons or to set allowed harvest numbers during those seasons.

Appendix B contains a complete list of methods available for use under this alternative. However, listing methods neither implies that all methods would be used by WS to resolve requests for assistance nor does the listing of methods imply that all methods would be used to resolve every request for assistance. As part of an integrated approach, WS may provide technical assistance and direct operational assistance to those people experiencing damage associated with predators when those persons request assistance from WS.

Technical Assistance Recommendations

Under Alternative 1, WS could provide technical assistance to those persons requesting assistance with managing damage as part of an integrated methods approach. Technical assistance provided by WS would occur as described in Alternative 3 of this EA. Education is an important element of technical assistance because wildlife damage management is about finding balance and coexistence between the needs of people and needs of wildlife. This is extremely challenging as nature has no balance, but rather is in continual flux. In addition to the routine dissemination of recommendations and information to individuals or organizations, WS provides lectures, courses, and demonstrations to producers, homeowners, state and county agents, colleges and universities, and other interested groups. WS frequently cooperates with other entities in education and public information efforts. Additionally, WS' employees would continue to write technical papers and provide presentations at professional meetings and conferences so that other wildlife professionals and the public are aware of recent developments in damage management technology, programs, laws and regulations, and agency policies.

Direct Operational Assistance

Operational damage management assistance would include damage management activities that WS' personnel conduct directly or activities that WS' employees supervise. Initiation of operational damage management assistance could occur when the problem could not be effectively resolved through technical assistance alone and there was a written MOU, work initiation document, or other comparable document signed between WS and the entity requesting assistance. The initial investigation by WS' personnel would define the nature, history, and extent of the problem; species responsible for the damage; and methods available to resolve the problem. The professional skills of WS' personnel could be required to resolve problems effectively, especially if chemical methods were necessary or if the problems were complex.

Research and Development

The National Wildlife Research Center (NWRC) functions as the research unit of WS by providing scientific information and the development of methods for wildlife damage management, which are effective and environmentally responsible (see WS Directive 2.115, WS Directive 2.120). Research biologists with the NWRC work closely with wildlife managers, researchers, and others to develop and evaluate methods and techniques for managing wildlife damage. Research biologists with the NWRC have authored hundreds of scientific publications and reports based on research conducted involving wildlife and methods.

WS' Decision Making Procedures

The WS Decision Model (see WS Directive 2.201) described by Slate et al. (1992) depicts how WS' personnel would use a thought process for evaluating and responding to damage complaints. WS' personnel would assess the problem and then evaluate the appropriateness and availability (legal and administrative) of strategies and methods based on biological, economic, and social considerations. Following this evaluation, WS' employees would incorporate methods deemed practical for the situation into a damage management strategy. After WS' employees implemented this strategy, employees would continue to monitor and evaluate the strategy to assess effectiveness. If the strategy were effective, the need for further management would end. In terms of the WS Decision Model, most efforts to resolve wildlife damage consist of continuous feedback between receiving the request and monitoring the results of the damage management strategy. The Decision Model is not a written documented process, but a mental problem-solving process common to most, if not all, professions, including WS.

The general thought process and procedures of the WS Decision Model would include the following steps.

1. **Receive Request for Assistance:** WS would only provide assistance after receiving a request for such assistance. WS would not respond to public bid notices.
2. **Assess Problem:** First, WS would make a determination as to whether the assistance request was within the authority of WS. If an assistance request were within the authority of WS, WS'

employees would gather and analyze damage information 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' employees could gather and analyze would include the current economic loss or current threat (*e.g*., threat to human safety), the potential for future losses or damage, the local history of damage, 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 was completed, a WS' employee would conduct an evaluation of available management methods. The employee would evaluate 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:** A WS' employee would formulate a management strategy using those methods that the employee determines to be practical for use. The WS employee would also consider factors essential to formulating each management strategy, such as available expertise, legal constraints on available methods, costs, and effectiveness.
5. **Provide Assistance:** After formulating a management strategy, a WS employee could provide technical assistance and/or direct operational assistance to the requester (see WS Directive 2.101).
6. **Monitor and Evaluate Results of Management Actions:** When providing direct operational assistance, it is necessary to monitor the results of the management strategy. Monitoring would be important for determining whether further assistance was required or whether the management strategy resolved the request for assistance. Through monitoring, a WS' employee would continually evaluate the management strategy to determine whether additional techniques or modification of the strategy was necessary.
7. **End of Project:** When providing technical assistance, a project would normally end after a WS' employee provided recommendations or advice to the requester. A direct operational assistance project would normally end when WS' personnel stop 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' personnel and may have no well-defined termination point.

Community-based Decision Making

WS could receive requests for assistance from community leaders and/or representatives. In those situations, the WS program in Oklahoma, under this alternative, would follow the "*co-managerial approach*" to solve wildlife damage or conflicts as described by Decker and Chase (1997). Within this management model, WS could provide technical assistance regarding the biology and ecology of predators and effective, practical, and reasonable methods available to the local decision-maker(s) to reduce damage or threats. This could include non-lethal and lethal methods. WS and other state and federal wildlife management agencies may facilitate discussions at local community meetings when resources were available. Under this approach, resource owners within a community and other community members directly or indirectly affected by predator damage or the management of damage would have direct input into the resolution of such problems. They may implement management recommendations provided by WS or others, or may request direct operational assistance from WS, other wildlife management agencies, local animal control agencies, private businesses, or seek no further assistance.

The community representative(s) and/or decision-maker(s) for the local community would be elected officials or representatives of the communities. The community representative(s) and/or decision-maker(s) who oversee the interests and business of the local community would generally be residents of the local community or appointees that other members of the community popularly elected. This person or persons would represent the local community's interest and make decisions for the local community or bring information back to a higher authority or the community for discussion and decision-making.

Identifying the decision-maker for local business communities can be more complex because building owners may not indicate whether the business must manage wildlife damage themselves, or seek approval to manage wildlife from the property owner or manager, or from a governing Board.

Under a community based decision-making process, WS could provide information, demonstration, and discussion on available methods to the appropriate representative(s) of the community and/or community decision-maker(s) that requested assistance, which would help ensure that decisions made by representatives of the community and/or the decision-makers were based on community-based input. WS would only provide direct operational assistance if the local community representative(s) and/or decision-maker(s) requested such assistance and only if the assistance requested was compatible with WS' recommendations.

By involving community representatives and/or community decision-makers in the process, WS could present information that would allow decisions on damage management to involve those individuals that the representatives and/or decision-maker(s) represent. As addressed in this EA, WS could provide technical assistance to the appropriate representative(s) and/or decision-maker(s), including demonstrations and presentation by WS at public meetings to allow for involvement of the community. Requests for assistance to manage damage caused by predators often originate from the decision-maker(s) based on community feedback or from concerns about damage or threats to human safety. As representatives of the community, the community representative(s) and/or decision-maker(s) would be able to provide the information to local interests either through technical assistance provided by WS or through demonstrations and presentation by WS on damage management activities. This process would allow WS, the community representative(s), and/or decision-maker(s) to make decisions on damage management activities based on local input. The community leaders could implement management recommendations provided by WS or others, or may request management assistance from WS, other wildlife management agencies, local animal control agencies, or private businesses or organizations.

Private Property Decision-makers

In the case of private property owners, the decision-maker is the individual that owns or manages the affected property. The decision-maker has the discretion to involve others as to what occurs or does not occur on property they own or manage. Therefore, in the case of an individual property owner or manager, the involvement of others and to what degree others were involved in the decision-making process would be a decision made by that individual. WS could provide direct operational assistance when requested; however, WS would only provide assistance if the requested management actions were in accordance with WS' recommendations.

Public Property Decision-makers

The decision-maker for local, state, or federal property would be the official responsible for or authorized to manage the public land to meet interests, goals, and legal mandates for the property. WS could provide technical assistance to this person and make recommendations to reduce damage. WS could provide direct operational assistance when requested; however, WS would only provide assistance if the requested management actions were in accordance with WS' recommendations.

Alternative 2 – WS Would Address Predator Damage through an Adaptive Integrated Approach Using Only Non-lethal Methods

Under this alternative, WS would implement an adaptive integrated methods approach as described under Alternative 1; however, WS would only consider non-lethal methods when formulating approaches to resolve damage associated with predators, wherever a property owner requests such assistance. WS could provide technical assistance and/or direct operational assistance similar to Alternative 1. The only methods that WS could recommend or use would be the non-lethal methods described in Appendix B and those methods would be identical to those non-lethal methods available and discussed under Alternative 1. Under this alternative, non-lethal methods would include fencing, deterrents/repellents, pyrotechnics, electronic guards (siren strobe-light devices), visual deterrents, fladry, exclusion, harassment, minor habitat alteration, cage traps, foothold traps, cable devices, decoy dogs, tracking dogs, and translocation (see Appendix B for a complete list). If WS were to conduct operational assistance, WS' personnel would translocate predators because lethal methods would be unavailable. Under this alternative, WS would not use fumigants, firearms, sodium cyanide (M-44 devices), or euthanasia chemicals.

WS would refer requests for information regarding lethal methods to the ODAFF, the ODWC, and/or private entities. Although WS would not recommend or use lethal methods under this alternative, other entities, including private entities, could continue to use lethal methods to resolve damage or threats. Property owners or managers could still resort to lethal methods or other methods not recommended by WS.

Alternative 3 – Predator Damage Management by WS through Technical Assistance Only

Under this alternative, WS would provide those cooperators requesting assistance with technical assistance only. Similar to Alternative 1 and Alternative 2, WS could receive requests for assistance from community representatives, private individuals/businesses, or from public entities. Technical assistance would provide those cooperators experiencing damage or threats associated with predators with information, demonstrations, and recommendations on available and appropriate methods. The implementation of methods and techniques to resolve or prevent damage would be the responsibility of the requester with no direct involvement by WS. In some cases, WS may provide supplies or materials that were of limited availability for use by private entities (*e.g.*, loaning of cage traps). Technical assistance may be provided through a personal or telephone consultation, or during an on-site visit with the requester. Generally, WS would describe several management strategies to the requester for short and long-term solutions to managing damage. WS would base those strategies on the level of risk, need, and the practicality of their application. WS would use the Decision Model to recommend those methods and techniques available to the requester to manage damage and threats of damage. Those persons receiving technical assistance from WS could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from other entities, or take no further action.

Under a technical assistance only alternative, WS would recommend an integrated approach similar to Alternative 1 and Alternative 2 when receiving a request for assistance; however, WS would not provide direct operational assistance under this alternative. WS would give preference to non-lethal methods when practical and effective under this alternative (see WS Directive 2.101). WS would base method and technique recommendations on information provided by the individual(s) seeking assistance using the WS Decision Model. In some instances, wildlife-related information provided to the requester by WS would result in tolerance/acceptance of the situation. In other instances, WS would discuss and recommend damage management options. WS would only recommend or loan those methods legally available for use by the appropriate individual. Similar to Alternative 1 and Alternative 2, those methods described in Appendix B would be available to those persons experiencing damage or threats associated with predators in the State; however, immobilizing drugs, euthanasia chemicals, sodium cyanide, and the shooting from an aircraft would have limited availability to the public and other entities under this alternative and Alternative 4. Licensed veterinarians or people under their supervision would be the only entities that could use immobilizing drugs and euthanasia chemicals. The availability of aircraft would also be limited, especially shooting from an aircraft. Shooting from an aircraft by entities other than WS to alleviate damage or threats of damage would require a permit from the ODAFF.

The WS program in the State regularly provides technical assistance to individuals, organizations, and other federal, state, and local government agencies for managing predator damage. Technical assistance would include collecting information about the species involved, the extent of the damage, and previous methods that the cooperator had attempted to resolve the problem. WS would then provide information on appropriate methods that the cooperator could consider to resolve the damage themselves. Types of technical assistance projects may include a visit to the affected property, written communication, telephone conversations, or presentations to groups such as homeowner associations or civic leagues.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, and/or private businesses. Those persons experiencing damage or were concerned with threats posed by predators could seek assistance from other governmental agencies, private entities, or conduct damage management on their own. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent predator damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Alternative 4 – No Predator Damage Management Conducted by WS

This alternative would preclude all activities by WS to reduce threats to human health and safety, and to alleviate damage to agricultural resources, property, and natural resources. WS would not provide assistance with any aspect of managing damage caused by predators in the State. WS would refer all requests for assistance to resolve damage caused by predators to the ODAFF, the ODWC, other governmental agencies, and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with predators in the State, those persons experiencing damage caused by predators could continue to resolve damage by employing those methods legally available since the removal of predators to alleviate damage or threats could occur despite the lack of involvement by WS. Similar to the other alternatives, most of those methods described in Appendix B would be available to those people experiencing damage or threats associated with predators in the State; however, immobilizing drugs, euthanasia chemicals, sodium cyanide, and the use of a firearm from an aircraft would have limited availability to the public and other entities under this alternative. Licensed veterinarians or people under their supervision would be the only entities that could use immobilizing drugs and euthanasia chemicals. The availability of aircraft would also be limited, especially shooting from an aircraft. Shooting from an aircraft by entities other than WS to alleviate damage or threats of damage would require a permit from the ODAFF.

Under this alternative, those persons experiencing damage or threats of damage could contact WS; however, WS would immediately refer the requester to the ODAFF, the ODWC, and/or to other entities. The requester could contact other entities for information and assistance with managing damage, could take actions to alleviate damage without contacting any entity, or could take no further action.

3.2 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL WITH RATIONALE

In addition to those alternatives analyzed in detail, WS and the ODAFF identified several additional alternatives. However, those alternatives will not receive detailed analyses for the reasons provided. Those alternatives considered but not analyzed in detail include the following.

The WS Program would Compensate People for Predator Damage

The compensation alternative would require WS to establish a system to reimburse persons impacted by predator damage and to seek funding for the program. Under such an alternative, WS would continue to provide technical assistance to those persons seeking assistance with managing damage. In addition, WS would conduct site visits to verify damage. Evaluation of this alternative indicates that a compensation only alternative has many drawbacks. Compensation would require large expenditures of money and labor to investigate and validate all damage claims, and to determine and administer appropriate compensation. Compensation most likely would be below full market value and would give little incentive to resource owners to limit damage through improved cultural or other practices and management strategies. In addition, providing compensation would not be practical for reducing threats to human health and safety.

The WS Program would establish a Bounty System for Predators

This alternative would require the WS program to establish a system that paid people for each predator they killed. A standard problem with bounties is that the circumstances surrounding the lethal removal of animals are typically unknown and completely unregulated, which is contrary to the tenants of the North American Model of Wildlife Conservation (Geist 2006, Organ et al. 2010). WS concurs because of several inherent drawbacks and inadequacies in the payment of bounties. Bounties are often ineffective at controlling damage over a wide area, such as across the entire State. The circumstances surrounding the removal of animals are typically unknown and completely unregulated because it is difficult or impossible to assure people did not remove animals claimed for bounty from outside the area where damage was occurring. In addition, WS does not have the authority to establish a bounty program.

The WS Program would Refer People to Private Nuisance Wildlife Control Agents or Trappers

Under this alternative, the WS program would refer all entities requesting assistance to private individuals or companies (*e.g.*, private trappers, wildlife control companies). People experiencing damage caused by predators could contact wildlife control agents and private entities to reduce predator damage when deemed appropriate by the resource owner. In addition, WS could refer persons requesting assistance to agents and/or private individuals under all of the alternatives fully evaluated in the EA.

WS Directive 3.101 provides guidance on establishing cooperative projects and interfacing with private businesses. WS would only respond to requests for assistance received directly and would not respond to public bid notices. When responding to requests for assistance, WS would inform requesters that other service providers, including private entities, might be available to provide assistance.

The WS Program would Implement Non-lethal Methods before Lethal Methods

This alternative would require that WS apply non-lethal methods or techniques described in Appendix B to all requests for assistance to reduce damage and threats to safety from predators in the State. If the use of non-lethal methods failed to resolve the damage situation or reduce threats to human safety at each damage situation, WS could then employ lethal methods to reduce damage or the threat of damage. WS would apply non-lethal methods to every request for assistance regardless of severity or intensity of the damage or threat until deemed inadequate to resolve the request. This alternative would not prevent the use of lethal methods by other entities or by those persons experiencing predator damage but would only prevent the use of those methods by WS until WS had employed non-lethal methods. The WS program could recommend the use of lethal methods through technical assistance under this alternative; however, the operational use of lethal methods would only occur after the use of non-lethal methods had proven ineffective.

Some non-lethal methods available to alleviate damage or threats associated with predators are impractical for implementation by WS' personnel, such as altering livestock management practices (*e.g.*, night-penning, herding, carcass removal) and physical exclusion (*e.g.*, predator-proof fencing). Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. Implementation of most non-lethal methods for livestock protection falls within the purview of the livestock producer (Knowlton et al. 1999). Many of those non-lethal methods (*e.g*., fencing and guard animals) require a large investment in time to implement and have a high initial cost (Mitchell et al. 2004). Even with the additional effort and costs, those methods are not always effective at reducing damage and potentially have side effects (*e.g*., concentrating livestock can cause unwanted damage to particular pasture areas) (Knowlton et al. 1999).

Producers in the United States spent nearly $188.5 million dollars on non-lethal methods to reduce cattle and calf losses from predation by animals in 2010 (NASS 2011). The primary non-lethal method employed by cattle producers in Oklahoma was the use of guard animals with a reported 41.8% of producers using guard animals. Producers also reported using additional non-lethal methods, with 24.7% using culling, 24.7% using exclusion fencing, 18.2% using livestock carcass removal, 16.7% using frequent checks, 14.3% using other non-lethal methods, 8.9% using herding, and 3.6% reporting the use of night penning, and 3.2% using fright tactics (NASS 2011).

Verification of the methods used would be the responsibility of WS. No standard exists to determine requester diligence in applying those methods, nor are there any standards to determine how many non-lethal applications are necessary before the initiation of lethal methods. Thus, WS could only evaluate the presence or absence of non-lethal methods. Alternative 1 and Alternative 3 would be similar to a non-lethal before lethal alternative because WS' personnel would give preference to the use of non-lethal methods before lethal methods (see WS Directive 2.101). Adding a non-lethal before lethal alternative and the associated analysis would not contribute additional information to the analyses in the EA.

WS Would Require Cooperators Pay All of the Cost of Lethal Removal to Increase the Availability of Funding for Assistance using Non-lethal methods

This alternative would be nearly identical to Alternative 1. The WS program in Oklahoma would continue to implement and recommend an adaptive integrated methods approach when the program receives a request for assistance. All of the methods discussed in the EA and Appendix B would continue to be available for use by the WS program in Oklahoma. However, under this alternative, when an entity requests assistance and allows the WS program to use lethal methods, the entity requesting assistance would pay all the costs associated with WS' use of those lethal methods. Therefore, any other funding provided to the WS program in Oklahoma would be available for the implementation of non-lethal methods.

However, implementation of this alternative would have adverse consequences in terms of unequal access to federal assistance with managing damage caused by predators. In some instances, cooperators contact WS after using non-lethal methods on their own but those non-lethal methods failed to resolve their damage problem. For example, cattle producers in the United States reported spending an estimated $188.5 million on non-lethal methods in 2010 just to reduce depredation on cattle (NASS 2011). Under this alternative, those producers who implement non-lethal methods would have to bear the fiscal burden of paying for WS' assistance with lethal methods even though they had made a good-faith effort to implement appropriate non-lethal methods. In contrast, a producer who had not implemented non-lethal methods or had only engaged in limited use of non-lethal methods on their own prior to contacting WS would qualify for federal assistance with non-lethal methods.

Additionally, the availability and efficacy of damage management methods are not equal for all types of damage. Consequently, WS would not have the ability to provide assistance equally because available public funding would only be available to individuals experiencing conflicts with predators based on the availability of suitable effective non-lethal methods and not on actual need for assistance or effort in seeking to implement non-lethal methods on their own.

This alternative would also be problematic when considered in context of Executive Order 12898 (see Section 1.6). If the WS program in Oklahoma implemented this alternative, the ability of the producer to afford to pay the expenses when WS' personnel used lethal methods would determine access to assistance from WS. Low-income people may not have the ability to pay for assistance from WS, particularly if they have already recently paid to implement new non-lethal methods. It is the policy of WS to use available public funds to assist people equally based on the need for action, not on their ability to pay for assistance. The WS program in Oklahoma did not consider this alternative in detail because of concerns associated with unequal access to federal fiscal assistance with managing damage caused by predators.

WS would implement a Non-lethal Damage Management program similar to the Marin County, California Program

Following public concerns over the use of lethal methods to manage predator damage, the Board of Supervisors in Marin County, California replaced a cooperative program between Marin County, the California Department of Food and Agriculture, and the WS program in California with a county-administered, program that promotes and provide some reimbursement to livestock producers that implement non-lethal methods. The County Agricultural Commissioner supervises the county program. Under the current program in Marin County, qualified ranchers are provided reimbursement to assist in the implementation of non-lethal methods to reduce livestock predation (*e.g*., through new fence construction or improvements to existing fences, guard animals, scare devices, or changes in animal husbandry) (Larson 2006, Fox 2008). The program provides a cost share mechanism that provides funds for purchasing fencing materials and guard animals (Larson 2006, Fox 2008).

To qualify for the program, livestock producers in the County must have at least 25 head of livestock and must utilize two non-lethal methods to deter predation verified by the Marin County Agricultural Commissioner. In addition, the cost-share reimbursement that livestock producers in the County can receive annually depends on the size of their livestock herd. For example, Fox (2008) reported that livestock producers with 200 head or more were eligible to receive up to $2,000, which was the maximum amount a producer could receive annually. Livestock producers with herds of between 25 and 199 head could receive up to $500 annually. Although the program provides cost-share reimbursement to livestock producers in the county for expenses associated with non-lethal methods, livestock producers can still use lethal methods and/or seek the assistance of other entities to employ lethal methods.

The environmental consequences associated with the implementation of Alternative 2 discussed in Section 3.1 would be similar to this alternative. In addition, if a federal, state, and/or county entity provides funding for cost share reimbursement to livestock producers similar to the program implemented in Marin County, California, WS could implement a similar program under Alternative 1, Alternative 2, or Alternative 3. Although Alternative 1 and Alternative 3 could include the implementation and/or recommendation of lethal methods by the WS program in Oklahoma (see Section 3.1), they would not require the WS program to use and/or recommend lethal methods to address all requests for assistance. In addition, a county or other entity could implement a program similar to the Marin County, California program on their own under any of the alternatives discussed.

A drawback to implementing a program similar to the program in Marin County, California would be the inability of the program to address several of the needs for action identified in Section 1.2. The Marin County program only provides cost share reimbursement to livestock producers in a single county within California. The program does not provide assistance with predator damage to other types of agricultural resources, damage to property, or provide assistance with managing threats to human health and safety.

Larson (2006) provides a discussion on the many limitations of the Marin County program, including the difficulties of transferring the program to other areas. WS has determined that detailed analysis of this alternative would not provide substantive new information to aid decision-making; therefore, the WS program in Oklahoma will not conduct a detailed analysis of this alternative at this time. The WS program in Oklahoma based this determination on the limitations of the Marin County program noted by Larson (2006), the failure of the program to address all the needs for action presented in Section 1.1, and the similarity of this alternative to other alternatives discussed in Section 3.1.

Use of Lethal Methods Only by WS

This alternative would require WS' personnel to use lethal methods only when providing assistance with managing threats and damage associated with predators. However, non-lethal methods can be effective in preventing damage in certain instances. Under WS Directive 2.101, WS must consider the use of non-lethal methods before lethal methods. In those situations where application of the WS Decision Model determines that using non-lethal methods would effectively reduce or prevent damage, WS' personnel would employ or recommend those methods. Therefore, WS did not consider this alternative in detail.

WS would only use Live-capture Methods and would Translocate Predators to Other Areas

Under this alternative, WS would address all requests for assistance using live-capture methods or the recommendation of live-capture methods and WS would translocate all predators live-captured. Predators would be live-captured using immobilizing drugs, live-traps, foothold traps, or cable devices. The success of translocation efforts would depend on efficiently capturing target predators and the existence of an appropriate release site (Nielsen 1988). WS would identify release sites prior to live-capture to ensure appropriate sites were available before initiating any activities.

The ODWC would have to approve and authorize the translocation and release of the individual target animals. The translocation of predators could only occur under the authority of the ODWC. Therefore, the translocation of predators by WS would only occur as directed by the ODWC. In addition, the property owner would have to authorize WS to release target animals on their property. When the ODWC authorizes translocation of target animals and when a property owner approves of WS releasing animals on their property, WS could translocate animals or recommend translocation under Alternative 1 and under Alternative 2. In addition, WS could recommend translocation under Alternative 3. Translocation by other entities could also occur under all of the alternatives.

Translocation may be appropriate in some situations when a species' population is low. However, most predators are abundant in much of the suitable habitat in Oklahoma, and translocation is not necessary for the maintenance of viable populations in the State. Because predator populations are abundant in Oklahoma, the predators that WS translocated and released into suitable habitat would very likely encounter other predators with established territories. For example, coyotes are territorial, and introducing translocated coyotes into new areas often disorientates the coyotes because they are unfamiliar with their surroundings. Therefore, translocated coyotes could often be at a disadvantage. Territorial coyotes often viciously attack other coyotes that wander into their territories and those injuries sustain during those attacks oftentimes causes the death of translocated coyote. Survival of translocated animals is generally very poor due to the stress of translocation, and in many cases, released animals suffer mortality in a new environment (Craven et al. 1998).

Translocation of wildlife is also discouraged by WS policy (see WS Directive 2.501) because of the stress to the translocated animal, threat of spreading diseases, poor survival rates, and the difficulties that translocated wildlife have with adapting to new locations or habitats (Dickens et al. 2010, Massei et al.

2010, Whisson et al. 2012). Since WS does not have the authority to translocate predators in the State unless permitted by the ODWC, WS did not consider this alternative in detail.

WS would use Non-lethal Methods and Approved Euthanasia Only to Address Damage

Under this alternative, WS would continue to employ an integrated methods approach but would only employ non-lethal methods to exclude, harass, or live-capture target predator species. When deemed appropriate, WS could continue to remove target predators lethally; however, under this alternative, WS would only use methods that captured target predators alive. Once live-captured, WS' personnel would euthanize target animals using methods that meet the definition of euthanasia as defined by the AVMA.

Euthanasia methods would be restricted to those defined by the AVMA (2013) as acceptable or acceptable with conditions, and would include sodium pentobarbital, potassium chloride, carbon dioxide, and firearms (once live-captured). This alternative would be similar to Alternative 1 since WS would give preference to the use of non-lethal methods when practical and effective (see WS Directive 2.101). In addition, WS' personnel would be familiar with the euthanasia methods described by the AVMA and would use those methods to euthanize captured or restrained animals, whenever practicable (see WS Directive 2.430, WS Directive 2.505). Therefore, WS did not consider this alternative in detail.

Reducing Damage by Managing Predator Populations through the Use of Reproductive Inhibitors

Under this alternative, the only method that would be available to resolve requests for assistance by WS would be the recommendation and the use of methods that reduce or prevent reproduction in predators responsible for causing damage. Wildlife professionals often consider reproductive inhibitors for use where wildlife populations are overabundant and where traditional hunting or lethal control programs were not publicly acceptable (Muller et al. 1997). Wildlife professionals could achieve a reduction in local wildlife populations through natural mortality combined with reduced fecundity. However, population dynamic characteristics (*e.g.*, longevity, age at onset of reproduction, population size, and biological/cultural carrying capacity), habitat and environmental factors (*e.g.*, isolation of target population, cover types, and access to target individuals), socioeconomic, and other factors often limit the use and effectiveness of reproductive control as a tool for wildlife population management. Population modeling indicates that reproductive control is more efficient than lethal control only for some rodent and small bird species with high reproductive rates and low survival rates (Dolbeer 1998). Additionally, the need to treat a sufficiently large number of target animals, multiple treatments, and population dynamics of free-ranging populations place considerable logistic and economic constraints on the adoption of reproduction control technologies as a wildlife management tool for some species.

Reproductive control for wildlife can occur through sterilization (permanent) or contraception (reversible). Sterilization could be accomplished through: 1) surgical sterilization (vasectomy, castration, and tubal ligation), 2) chemosterilization, and 3) through gene therapy. Contraception could be accomplished through: 1) hormone implantation (synthetic steroids such as progestins), 2) immunocontraception (contraceptive vaccines), and 3) oral contraception (progestin administered daily). Currently, chemical reproductive inhibitors are not available for use to manage predator populations.

Bromley and Gese (2001*a*, 2001*b*) conducted studies to determine if surgically sterilized coyotes would maintain territories and pair bond behavior characteristics of unsterilized coyotes, and if predation rates by sterilized coyote pairs would decrease. The results indicated that behaviorally, sterile coyote pairs appeared to be no different from unsterilized pairs, except for predation rates on lambs. Unsterilized coyote packs were six times more likely to prey on sheep than were sterilized packs (Bromley and Gese 2001*b*). Bromley and Gese (2001*b*) 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 wildlife professionals could capture and sterilize enough coyote breeding pairs. Bromley and Gese (2001*a*, 2001*b*) captured as many coyotes as possible from all packs on their study area and controlled coyote exploitation (mortality) on their study area. During their studies, Bromley and Gese (2001*a*, 2001*b*) found survival rates for coyotes in the unexploited study area were similar to those survival rates reported for mostly unexploited wild coyote populations. Seidler and Gese (2012) found similar results. Bromley and Gese (2001*b*) concluded a more effective and economical method of sterilizing resident coyotes was needed to make sterilization a practical management tool on a larger scale. Seidler et al. (2014) concluded that surgical sterilization of coyotes could reduce predation rates on pronghorn (*Antilocapra americana*) fawns.

Trap, neuter, and release programs for feral cats are often not as successful as desired and needed to reduce immediate threats, especially when human safety is a concern (Barrows 2004, Levy and Crawford 2004, Jessup 2004, Winter 2004, AVMA 2014). Feral animals subjected neutering would continue to cause the same problems[13] they caused before the trap, neuter, and release program was initiated because of slow attrition. Trap, neuter, and release programs can take a decade or longer to reduce target species populations (Barrows 2004, Winter 2004), especially when acute issues need rapid solutions (Levy and Crawford 2004, Stoskopf and Nutter 2004). Several studies report that target species' populations often remain stable or increase following trap, neuter, and release programs due to immigration and reproduction from other members of the groups (Castillo and Clarke 2003, Levy and Crawford 2004, Winter 2004) with little to no resolution of threats to human safety or damages (Barrows 2004, Slater 2004, Winter 2004).

Surgical sterilization would require that each animal be captured and sterilization conducted by licensed veterinarians, which could be labor intensive and expensive. Given the costs associated with live-capturing and performing sterilization procedures on predators and the lack of availability of chemical reproductive inhibitors for the management of predator populations, this alternative was not evaluated in detail. As alternative methods of delivering chemosterilants are developed, sterilization may prove to be a practical tool in some circumstances (DeLiberto et al. 1998). If reproductive inhibitors become available and research proves those inhibitors are effective in reducing localized predator populations, WS could evaluate the use of the inhibitor as a method available to manage damage.

WS would not Use Lethal Methods until More Rigorous Scientific Testing Shows an Individual Method to be Effective

Some people have questioned the efficacy of lethal tools and techniques to manage wildlife damage and express their opposition to their use. A recent paper published by Treves et al. (2016) criticizes certain research on lethal methods and the they recommend suspending the use of those methods until more rigorous scientific testing prove their efficacy. Treves et al. (2016) advocate for new study designs that use the same standards as those in controlled laboratory settings for biomedical research. Research scientists with the NWRC have evaluated the paper published by Treves et al. (2016) and do not agree with the assessment that existing research is flawed. Further, field studies and laboratory studies require different study designs. After review of the paper published by Treves et al. (2016), the WS program the critique contained serious errors in interpretation of field-study designs that are well established.

There are important differences between research studies conducted in a field environment and studies in biomedical laboratory settings. Field research inherently brings in variables such as weather, varying habitat quality, and movement of wildlife that researchers cannot control. Researchers in field settings

[13] Brickner (2003), Levy et al. (2003), Barrows (2004), and Jessup (2004) reported that sterilized cats that do not spend any time on courting and mating are left with more time to hunt than non-sterilized cats and therefore, continue to remain as potential reservoirs of animal and human disease, a social nuisance, and continue to hunt and kill protected species.

must make assumptions when trying to answer complex ecological questions in field settings. Researchers address and acknowledge those variables in field research using well-established and recognized field study designs, such as the switch-back and paired block designs. In addition, the paper published by Treves et al. (2016) did not accurately interpret or represent the studies' designs or results of at least two research papers they analyzed, which raises questions regarding additional misrepresentations and errors in their paper.

WS agrees that tools and techniques that people use to manage wildlife damage must be based on scientifically sound principles. Research scientists at the NWRC are dedicated to gathering information, testing new ideas and methods, and using experiments (versus observational studies) as much as possible. Research scientists with the NWRC are leaders in the design and implementation of controlled studies to evaluate methods. Scientists with the NWRC collaborate with experts from around the world to conduct those studies and they often publish their findings in peer-reviewed literature[14]. A more detailed evaluation of Treves et al. (2016) is contained in Appendix C.

Because of site-specific variations in the efficacy of methods, the WS Decision Model, discussed in Section 3.1, allows WS' personnel to continually evaluate activities at each project site and adjust the methods as needed to achieve management objectives while also minimizing environmental impacts. Therefore, WS' personnel would consider the effectiveness of methods as part of the decision making-process when WS' personnel use the Decision Model for each request for assistance by continually evaluating methods and the results. Therefore, the WS program did not address the efficacy of methods as a separate issue in detail.

WS has determined that detailed analysis of this alternative would not provide substantive new information to aid the decision-maker. The WS program in Oklahoma based this determination on the deficiencies of the paper published by Treves et al. (2016) that WS discussed previously and further discusses in Appendix C. In addition, the implementation of this alternative would be similar to Alternative 2 discussed in Section 3.1; therefore, the WS program in Oklahoma will not conduct a detailed analysis of this alternative at this time.

WS would only Conduct Activities after Damage Had Occurred

Managing damage proactively and reactively are the general approaches to alleviating damage cause by predators (Baker et al. 2008). Proactive damage management would be the application of methods to target predators prior to damage occurrences based on historical damage that has occurred (*i.e*., based on a threat of damage) and the risk of damage. As requested and appropriate, the WS program provides information, conducts demonstrations, or take actions to prevent damage from recurring. For example, in areas where substantial livestock depredation has historically occurred, WS could provide information about guard dogs, fences, or other husbandry techniques, or be requested to provide direct operational assistance to remove predators prior to the period of greatest risk. Reactive damage management would be the application of methods targeting predators in response to an incurred loss with the intent of abating or reducing further losses (*i.e*., after damage has already occurred). Under this alternative, the WS program would only provide reactive assistance and only conduct activities after damage has occurred. WS would provide no proactive assistance; however, other entities could continue to provide proactive assistance by conducing activities based on a threat of damage. WS would only conduct activities based on a request for assistance. The use of both proactive and reactive damage management can increase the likelihood of reducing damage to acceptable thresholds (Conover 2002, Baker et al. 2008).

[14] At the time this EA was developed, many of the papers published by scientists with the NWRC that address predators can be found be visiting the website at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nwrc/research-areas/predator-research/ct_predators_publications.

In a ruling for Southern Utah Wilderness Alliance, et al. vs. Hugh Thompson, Forest Supervisor for the Dixie National Forest, et al., the United States District Court of Utah determined that a forest supervisor could establish a need for wildlife damage management if the supervisor could show that damage from wildlife was threatened (Civil No. 92-C-0052A January 20, 1993). The Court stated that, *"The agency need not show that a certain level of damage is occurring before it implements a [*WS*] Program… Hence, to establish need for* [WS]*, the forest supervisors need only show that damage from predators is threatened."* Thus, there is judicial precedence indicating that it is not necessary to establish a criterion, such as a percentage of loss of a particular resource to justify the need for damage management actions.

WS should establish a Loss Threshold before Allowing Lethal Methods

One issue identified through WS' implementation of the NEPA processes is a concern that WS or other entities should establish a threshold of loss before employing lethal methods to resolve damage and that wildlife damage should be a cost of doing business. In some cases, cooperators likely tolerate some damage and economic loss until the damage reaches a threshold where the damage becomes an economic burden. The appropriate level of allowed tolerance or threshold before employing lethal methods would differ among cooperators and damage situations. In some cases, any loss in value of a resource caused by predators could be financially burdensome to some people. In addition, establishing a threshold would be difficult or inappropriate to apply to human health and safety situations. For example, aircraft striking predators could lead to property damage and could threaten passenger safety if a catastrophic failure of the aircraft occurred because of the strike. Therefore, addressing the threats of wildlife strikes prior to an actual strike occurring would be appropriate.

Short Term Eradication and Long Term Population Suppression

An eradication alternative would direct all WS' program efforts toward total long-term elimination of predator populations wherever a person initiated a cooperative program with WS in Oklahoma. Eradication of native wildlife species is not a desired population management goal of WS, the ODAFF, the ODWC, or other wildlife resource agencies. WS and the ODAFF did not consider eradication as a general strategy for managing predator damage because WS, the ODAFF, the ODWC, and other state and federal agencies with interest in, or jurisdiction over, wildlife oppose eradication of any native wildlife species and eradication is not acceptable to most people.

Suppression would direct WS' program efforts toward managed reduction of certain problem populations or groups. The ODWC has the authority to regulate hunting seasons and tag quotas in the State to reduce wildlife populations. In addition, in areas where WS could attribute damage to localized populations of predators, WS could decide to implement local population suppression using the WS Decision Model. However, large-scale population suppression would not be realistic or practical to consider as the basis of the WS program. Problems with the concept of suppression would be similar to those described above for eradication. Typically, WS would conduct activities on a very small portion of the sites or areas inhabited or frequented by predators in the State.

WS should use Lithium Chloride as an Aversive Agent

This alternative would require WS to use only lithium chloride to manage damage or threats of damage associated with predators. Researchers have evaluated lithium chloride as a taste aversion agent to condition coyotes to avoid livestock, especially sheep. Despite extensive research, the efficacy of this technique remains unproven to prevent livestock predation (Conover et al. 1977, Sterner and Shumake 1978, Burns 1980, Burns and Connolly 1980, Burns 1983, Horn 1983, Johnson 1984, Burns and Connolly 1985). Results of studies evaluating lithium chloride as a taste aversion agent to prevent coyote predation have reported varying results. Some studies report success using lithium chloride (Gustavson et al. 1974, Ellins and Martin 1981, Gustavson et al. 1982, Forthman-Quick et al. 1985*a*, Forthman-Quick et al. 1985*b*), while other studies have shown lithium chloride to be ineffective, especially in field situations (Conover et al. 1977, Burns 1980, Bourne and Dorrance 1982, Burns 1983, Burns and Connolly 1985). The United States General Accounting Office (2001) reported "…*while the coyotes learned not to eat lambs, they still killed them*". In addition, lithium chloride is currently not registered for use with the EPA to prevent predation. Therefore, at the time this EA was developed, products containing lithium chloride were not available to prevent predation. If a product containing lithium chloride becomes available to manage damage and if the product is effective in reducing predation rates, WS could consider the use of the lithium chloride as a method available that could be used to managing damage. Managing damage, other than livestock predation by coyotes, would not be possible using just lithium chloride. To be effective target animals must ingest the lithium chloride, which would not resolve other damage situations (*e.g*., disease threats, property damage). Therefore, WS and the ODAFF did not consider this alternative in detail.

3.3 STANDARD OPERATING PROCEDURES FOR PREDATOR DAMAGE MANAGEMENT

SOPs are formalized procedures that serve as operational plans to ensure that people employ tasks and procedures with consistency (Reidinger and Miller 2013). SOPs provide quality assurance and improve the safety, selectivity, and efficacy of activities intended to resolve animal damage. The WS program in Oklahoma uses many such SOPs. Under the appropriate alternatives, WS' personnel would incorporate those SOPs into activities when addressing predator damage and threats in the State. Most SOPs abate specific issues while some are more general and relate to the overall program.

Some key SOPs pertinent to resolving predator damage in the State include the following:

- WS' employees would consistently use and apply the WS Decision Model when addressing predator damage to identify effective strategies to managing damage and the potential effects. Decisions made using the model would be in accordance with WS' directives (see WS Directive 1.101) and SOPs described in this EA.

- WS personnel would comply with applicable federal, state, and local laws and regulations (see WS Directive 2.201).

- WS' personnel would follow EPA-approved label directions for all pesticide use (see WS Directive 2.401). The intent of the registration process for chemical pesticides is to assure minimal adverse effects occur to the environment when people use the chemicals in accordance with label directions.

- WS' employees would use approved immobilizing drugs and euthanasia chemicals according to the United States Drug Enforcement Administration, United States Food and Drug Administration, and WS' directives and procedures (see WS Directive 2.430).

- WS' employees would follow approved procedures outlined in the WS' Field Manual for the Operational Use of Immobilizing and Euthanizing Drugs (Johnson et al. 2001).

- WS' employees that use controlled substances would receive training to use each material and would receive certification to use controlled substances.

- WS' employees who use pesticides and controlled substances would participate in State-approved continuing education to keep current of developments and maintain their certifications (see WS

Directive 2.401).

- Pesticide and controlled substance use, storage, and disposal would conform to label instructions and other applicable laws and regulations, and Executive Order 12898.

- WS would provide Material Safety Data Sheets for pesticides and controlled substances to personnel involved with specific damage management activities.

- All personnel who use firearms would receive training according to WS' Directives (see WS Directive 2.615).

- WS' employees participating in any aspect of aerial operations would receive training and/or would receive certification in their role and responsibilities during the operations. All WS' personnel would follow the policies and directives set forth in WS Directive 2.620; WS' Aviation Operations Manual; WS' Aviation Safety Manual and its amendments; Title 14 CFR; and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137.

- WS' personnel would consider the use of non-lethal methods prior to the use of lethal methods when managing predator damage (see WS Directive 2.101).

- The removal of predators by WS would only occur when authorized by the ODWC, when applicable, and only at levels authorized.

- WS' personnel would direct management actions toward localized populations, individuals, or groups of predators. WS' personnel would not conduct generalized population suppression across Oklahoma, or even across major portions of the State.

- WS' personnel would release non-target animals live-captured in traps unless an employee determined that the animal would not survive and/or that releasing the animal could not occur safely.

- The use of all traps, cable devices, and other capture devices by WS' personnel would adhere to WS Directive 2.450.

3.4 ADDITIONAL STANDARD OPERATING PROCEDURES SPECIFIC TO THE ISSUES

Several additional SOPs would be applicable to the alternatives and the issues identified in Chapter 2 including the following:

Issue 1 - Effects of Damage Management Activities on Target Predator Populations

- The WS program in Oklahoma would document the lethal removal of predators annually. In cooperation with the ODWC, the lethal removal of predators by WS would be monitored to evaluate effects to the statewide populations of predators.

- WS would only target those individuals or groups of animals identified as causing damage or posing a threat to human safety.

- WS' personnel would use the WS Decision Model, designed to identify the most appropriate damage management strategies and their impacts, to determine strategies for resolving predator damage.

- The WS program would monitor activities under the selected alternative to ensure activities continued to occur pursuant to the selected alternative. However, under the no involvement by WS alternative, no monitoring would occur by WS.

- WS' personnel would give preference to non-lethal methods, when practical and effective.

Issue 2 - Effects of Predator Damage Management Activities on the Populations of Non-target Wildlife Species, Including T&E Species

- WS' personnel would have experience and receive training to select the most appropriate method(s) to address target animals and avoiding risks to non-target species.

- WS' personnel work with research programs to continue to improve the selectivity and effectiveness of management devices.

- When conducting removal operations via shooting, identification of the target would occur prior to application.

- As appropriate, WS' personnel would use suppressed firearms to minimize the noise associated with the discharge of a firearm.

- Personnel would use lures, trap placements, and capture devices that personnel would place strategically at locations likely to capture a target animals and minimize the potential of non-target animal captures.

- To minimize the capture of non-target species that weigh less than the target species, WS commonly uses pan tension devices on foothold traps and foot snares.

- When using carcasses to attract predators, traps and snares would not be set within 30 feet of exposed carcasses to prevent the capture of scavenging birds, such as bald eagles and golden eagles.

- Sodium cyanide in the M-44 ejector would be used in accordance with the label and use restrictions.

- Personnel would release any non-target animals live-captured in cage traps, foothold traps, or any other restraining device whenever it was possible and safe to do so.

- WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. Personnel would directly monitor some live-capture methods (*e.g.*, immobilizing drugs administered through a dart gun), which ensures that personnel could avoid or release non-target species quickly, if captured. In most cases, WS' personnel would check other live-traps (*e.g.*, cage traps, foothold traps, restraining cables), which do not require direct monitoring, in accordance with Oklahoma laws and regulations. Checking traps frequently would help ensure that personnel could release live-captured non-target species in a timely manner.

- Pilots conducting aerial operations would abide by the WS Aviation Operations and Safety Manual and Federal Aviation Regulations. Non-target wildlife would not be pursued and when seen would be avoided, whenever possible.

- Personnel would dispose of the carcasses retrieved in accordance with WS Directive 2.515.

- WS has reviewed and would continue to review the list of species in Oklahoma on the Federal List of Endangered and Threatened Wildlife. As appropriate, the WS program in Oklahoma would continue to consult with the USFWS pursuant to Section 7 of the ESA when WS determines activities may affect a threatened or endangered species.

- WS would monitor activities conducted under the selected alternative, if activities were determined to have no significant impact on the environment and an EIS was not required, to ensure those activities do not negatively affect non-target species.

- WS' personnel would review all projects proposed for implementation for potential to take[15] bald eagles and golden eagles in accordance with the provisions of the Bald and Golden Eagle Protection Act. If WS' personnel identify potential risks of take, WS would work with the USFWS on measures to reduce risks and the need for a non-purposeful take permit.

- To limit the unintentional removal of swift fox using M-44 devices in locations where livestock losses to coyotes were not specifically verified, M-44 devices would be removed if a swift fox were unintentionally killed by an M-44 device and M-44 devices would not be used within a 3.5-km radius around the location where the swift fox was removed unintentionally.

Issue 3 - Effects of Predator Damage Management Activities on Human Health and Safety

- WS' personnel would conduct damage management activities professionally and in the safest manner possible. Whenever possible, personnel would conduct damage management activities away from areas of high human activity. If this were not possible, then personnel would conduct activities during periods when human activity was low (*e.g.*, early morning), whenever possible.

- WS' personnel would use the WS' Decision Model (see WS Directive 2.201) when selecting methods to use and/or recommend (see WS Directive 2.101), including consideration for the safety of people and employees (see WS Directive 2.210, WS Directive 2.601, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.625).

- WS' personnel would conduct shooting during times when public activity and access to the control areas were restricted, whenever possible. Personnel involved in shooting operations would receive training in the proper and safe application of this method.

- All personnel employing chemical methods would receive proper training and certification in the use of those chemicals. All chemicals used by WS would be securely stored and properly monitored to ensure the safety of the public. WS Directive 2.401, WS Directive 2.405, WS Directive 2.430, and WS Directive 2.465 outline WS' use of chemicals and the training requirements to use those chemicals.

---

[15]The Bald and Golden Eagle Protection Act defines "*take*" 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.

- All chemical methods used by WS or recommended by WS would be registered with the EPA, the United States Drug Enforcement Administration, the United States Food and Drug Administration, and/or the ODAFF, as appropriate.

- WS would adhere to all established withdrawal times for predators when using immobilizing drugs for the capture of predators that were agreed upon by WS, the ODWC, and veterinarian authorities. Although unlikely, in the event that WS was requested to immobilize predators during a time when harvest of those predator species was occurring or during a time where the withdrawal period could overlap with the start of a harvest season, WS would euthanize the animal or mark the animal with a tag. Tags would be labeled with a "*do not eat*" warning and appropriate contact information.

- Carcasses of predators retrieved after damage management activities would be disposed of in accordance with WS Directive 2.515.

- WS' personnel would receive training to properly place and set M-44 devices. Only those personnel who receive the appropriate applicator certification from the ODAFF to use sodium cyanide would place and set M-44 devices. Personnel would use M-44 devices in accordance with ODAFF and EPA regulations and label restrictions, including WS Directive 2.415.

- WS' personnel would place conspicuous, bilingual warning signs alerting people to the presence of traps, snares, and M-44 devices at major access points to the property where personnel use those methods.

- Training and certification would be required of crewmembers involved with aerial operations. This certification process includes training in the use of personal protective equipment, emergency procedures in the event of an aerial accident, target identification, and additional firearms training specific to aircraft. Commercial rated pilots must pass a Class II physical exam as defined by the FAA and are subjected to recurrent WS safety training for low-level aircraft. Aircraft would be inspected to meet or exceed Part 135 FAA aircraft standards.

Issue 4 - Humaneness and Animal Welfare Concerns of Methods

- Personnel would receive training in the latest and most humane devices/methods for removing target animals causing damage.

- WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. Personnel would directly monitor some live-capture methods (*e.g.*, immobilizing drugs administered through a dart gun), which ensures that personnel could avoid or release non-target species quickly, if captured. In most cases, WS' personnel would check other live-traps (*e.g.*, cage traps, foothold traps, restraining cables), which do not require direct monitoring in accordance with Oklahoma laws and regulations. Checking traps frequently would help ensure that personnel could release live-captured non-target species in a timely manner.

- When deemed appropriate using the WS Decision Model, WS' use of lethal methods would comply with WS' directives (*e.g.*, see WS Directive 2.401, WS Directive 2.430, WS Directive 2.505).

- The NWRC is continually conducting research to improve the selectivity and humaneness of wildlife damage management devices used by personnel in the field.

- ♦ WS' personnel would consider the use of non-lethal methods prior to the use of lethal methods when managing predator damage.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Chapter 4 provides information needed for making informed decisions when selecting the appropriate alternative to address the need for action described in Chapter 1 and the issues described in Chapter 2. This chapter analyzes the environmental consequences of each alternative as that alternative relates to the identified issues.

Irreversible and Irretrievable Commitments of Resources

Other than relatively minor uses of fuels for motor vehicles and electricity for office operations, no irreversible or irretrievable commitments of resources result from the WS program.

Cumulative and Unavoidable Impacts

Chapter 4 analyzes the environmental consequences of each alternative as that alternative relates to the identified issues in comparison with Alternative 1 to determine if the potential impacts are greater, lesser, or similar. The analyses discuss the cumulative effects in relationship to each of the alternatives analyzed, with emphasis on potential cumulative effects from methods employed, and including summary analyses of potential cumulative impacts to target and non-target species, including T&E species.

4.1 EVALUATION OF SIGNIFICANCE

Chapter 4 evaluates the direct, indirect, and cumulative impacts associated with the alternatives under each of the issues. The NEPA describe the elements that determine whether an impact is "*significant*". Significance is dependent upon the context and intensity of the action. WS and the ODAFF considered the following factors when reviewing the context and intensity of the alternatives:

Magnitude of the Impact

The magnitude of the impact is based on the size, number, or relative amount of impact (intensity). For example, the analysis that occurs in Chapter 4 measures the number of individual animals lethally removed in relation to the abundance of that animal to determine the magnitude of impact to the populations from the use of lethal methods. Magnitude may be determined either quantitatively or qualitatively. Determinations based on population estimates, allowable harvest levels, and actual harvest data would be quantitative. Determinations based on population trends and harvest trend data, when available, would be qualitative

Duration and Frequency of the Action

The duration and frequency of the impact relates to factors, such as, is the impact temporary, seasonal, or ongoing throughout the year (intensity). The duration and frequency of activities associated with the alternatives would be highly variable. Abiotic and biotic factors affecting predator behavior would affect the duration and frequency of activities conducted by WS under the alternatives. Although activities may involve programs of long duration, the frequency of individual activities within the program may be highly variable depending upon spatial, temporal, and biotic factors affecting the behavior of the predators that are causing damage. For instance, the lethal removal of several predators that continue to depredate may be very infrequent if non-lethal techniques prevent additional predators from habituating to the area. Projects involving damage management activities at individual sites are generally of short duration but may happen frequently at different sites.

Likelihood of the Impact

This factor can relate to the likelihood that a particular damage management action will be needed, and to the likelihood that an impact may occur because of a damage management action. For example, the likelihood that an abundant predator, such as a coyote, may be managed (harassment or lethal removal) to reduce depredations may be relatively high, but the need to harass or remove other less abundant predators may be much lower. Likewise, although some impacts on non-target species may be theoretically possible, the likelihood that the impact would occur may be negligible or nonexistent because of SOPs used by WS.

Geographic Extent

Activities conducted under the alternatives could occur anywhere in Oklahoma where damage management assistance has been requested, agreements for such actions are in place, and action is warranted, as determined by the WS Decision Model (Slate et al. 1992). Oklahoma encompasses about 68,585 square miles of land area. However, the WS program only has agreements to conduct activities associated with predators on a small portion of land in the state and not all properties where assistance is requested may need assistance in any given year. Additionally, WS generally only conducts activities on a small portion of the land acres allowed under a MOU, work initiation document, or another comparable document. For example, a landowner may allow WS to conduct activities on the 100 acres they own but WS' personnel might only conducted activities on 10 acres of the property.

4.2 ENVIRONMENTAL CONSEQUENCES FOR ISSUES ANALYZED IN DETAIL

This section analyzes the environmental consequences of each alternative in comparison to determine the extent of actual or potential impacts on the issues. Therefore, Alternative 1 serves as the baseline for the analysis and the comparison of expected impacts among the alternatives. The analysis also takes into consideration mandates, directives, and the procedures of WS, the ODWC, and the ODAFF.

Issue 1 - Effects of Damage Management Activities on Target Predator Populations

A common issue is whether damage management actions would adversely affect the populations of target predator species, especially when lethal methods were employed. The analysis for magnitude of impact from lethal removal can be determined either quantitatively or qualitatively. Quantitative determinations are based on population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations are based on population trends and harvest trend data. Information on predator populations and trends are often derived from several sources, including published literature and harvest data.

Methods available to address predator damage or threats of damage in the State that would be available for use or recommendation under Alternative 1 (proposed action/no action alternative) and Alternative 3 (technical assistance only alternative) would either be lethal methods or non-lethal methods. Those same methods would also be available to other entities under Alternative 2 (use of non-lethal methods only by WS) and Alternative 4 (no involvement by WS alternative). Under Alternative 3, the WS program could recommend lethal and non-lethal methods as part of an integrated approach to resolving requests for assistance. Non-lethal methods that could be available would include, but would not be limited to, habitat behavior modification, pyrotechnics, visual deterrents, cage traps, foothold traps, padded foothold traps, foot snares, translocation, exclusionary devices, tracking dogs, decoy dogs, frightening devices, fladry, immobilizing drugs, and chemical repellents (see Appendix B for a complete list and description of potential methods).

Non-lethal methods that would be available under all of the alternatives can disperse or otherwise make an area unattractive to predators causing damage; thereby, reducing the presence of those predators at the site and potentially the immediate area around the site where non-lethal methods were employed. WS' personnel would give priority to non-lethal methods when addressing requests for assistance under Alternative 1, Alternative 2, and Alternative 3 (see WS Directive 2.101). However, WS' personnel would not necessarily employ or recommend non-lethal methods to resolve every request for assistance if deemed inappropriate by personnel using the WS Decision Model. For example, if a cooperator requesting assistance had already used non-lethal methods, WS would not likely recommend or continue to employ those particular methods since their use had already been proven ineffective in adequately resolving the damage or threat.

Many non-lethal methods would be used to exclude, harass, and disperse target wildlife from areas where damage or threats were occurring. When effective, non-lethal methods would disperse or exclude predators from the area resulting in a reduction in the presence of those predators at the site where those methods were employed. However, predators responsible for causing damage or threats could be dispersed to other areas with minimal impact on those species' populations. Non-lethal methods would not be employed over large geographical areas or applied at such intensity that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope that long-term adverse effects would occur to a species' population. Non-lethal methods would generally be regarded as having minimal impacts on overall populations of wildlife since individuals of those species were unharmed. The use of non-lethal methods would not have adverse impacts on predator populations in State under any of the alternatives.

The continued use of many non-lethal methods can often lead to the habituation of predators to those methods, which can decrease the effectiveness of those methods. For any management methods employed, the proper timing would be essential in effectively dispersing those predators causing damage. Employing methods soon after damage begins or soon after threats were identified would increase the likelihood that those damage management activities would achieve success in addressing damage. Therefore, the coordination and timing of methods would be necessary to be effective in achieving expedient resolution of predator damage.

Lethal methods would also be available for use under all the alternatives. Lethal methods that would be available to address predator damage include live-capture followed by euthanasia, firearms, shooting from aircraft, calling and shooting, neck snares, body-gripping traps, fumigants (coyotes, red fox, striped skunks only), cable devices, sodium cyanide (coyotes, fox, feral dogs only), and the recommendation of harvest during hunting and/or trapping, where appropriate.

When live-captured target animals were to be euthanized under Alternative 1, euthanasia would occur pursuant to WS Directive 2.505 and WS Directive 2.430. Under alternative 3, the WS program would recommend the use of methods to euthanize live-captured or restrained target animals in accordance with WS Directive 2.505. No assistance would be provided by the WS program under Alternative 4 and only non-lethal methods would be recommended or employed by WS under Alternative 2; however, many of those methods available to euthanize live-captured or restrained animals would continue to be available for use by other entities under Alternative 2 and Alternative 4.

The use of lethal methods by any entity could result in local population reductions in the area where damage or threats were occurring since target individuals would be removed from the population. Lethal methods could be employed or recommended to remove predators that have been identified as causing damage or posing a threat to human safety. Therefore, the use of lethal methods could result in local reductions of predators in the area where damage or threats were occurring. The number of predators removed from the population annually by WS using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of predators involved with the associated damage or threat, and the efficacy of methods employed. The number of predators that could be removed by other entities under Alternative 2, Alternative 3, and Alternative 4 would be unknown but would likely be similar to the removal that could occur under Alternative 1.

Most lethal methods would be employed to reduce the number of predators present at a location since a reduction in the number of predators at a location could lead to a reduction in damage, which would be applicable whether using lethal or non-lethal methods. The intent of non-lethal methods would be to harass, exclude, or otherwise make an area unattractive to predators, which disperses those predators to other areas leading to a reduction in damage at the location where those predators were dispersed. The intent of using lethal methods would be similar to the objective trying to be achieved when using non-lethal methods, which would be to reduce the number of predators in the area where damage was occurring; thereby, reducing the damage occurring at that location.

Often of concern with the use of lethal methods is that predators that were lethally removed would only be replaced by other predators either during the application of those methods (*e.g.*, predators that relocate into the area) or by predators the following year (*e.g.*, increase in reproduction and survivability that could result from less competition). As stated previously, WS would not use lethal methods during direct operational assistance as population management tools over broad areas. Lethal methods would be employed under Alternative 1 to reduce the number of target animals present at a location where damage was occurring by targeting those animals causing damage or posing threats. The return of predators to areas where methods were previously employed does not indicate previous use of those methods were ineffective since the intent of those methods were to reduce the number of predators present at a site where predation was occurring or could occur at the time those methods were employed.

WS maintains ongoing contact with the ODWC to ensure activities are within management objectives for target species. WS submits activity reports to the ODWC to aid with their ongoing monitoring efforts. The ODWC has the authority to manage populations of predators as they determine is appropriate without oversight or control by federal agencies. Management direction for a given species can vary among states, and state management actions are not subject to compliance with the NEPA. Therefore, the status quo for the environment with respect to state-managed wildlife species is the management direction established by the states. Federal actions that are in accordance with state management have no effect on the status quo. Wildlife populations are typically dynamic and can fluctuate without harvest or control by people. Therefore, the status quo for wildlife populations is fluctuation, both within and among years, which may affect perceptions of the significance of the human impact on such populations.

Maintaining viable populations of all native species is a concern of the public and of biologists within state, tribal, and federal wildlife and land management agencies, including WS. The United States General Accounting Office (1990) analyzed the effects damage management activities conducted by the WS program on predators in the western United States and determined that WS' activities had no overall effect on predator populations. Several species' populations have steadily increased over the past several years due to the adaptability of those wildlife species to human-altered environments, and damage from those species has increased accordingly (International Association of Fish and Wildlife Agencies 2005). To evaluate the potential cumulative effects associated with implementing the alternatives, the magnitude associated with lethally removing coyotes to alleviate damage occur below for each alternative.

Alternative 1 - Continue the Current Adaptive Integrated Methods Approach to Managing Predator Damage (No Action/Proposed Action)

Under Alternative 1, WS would continue to provide both technical assistance and direct operational assistance to those persons requesting assistance with managing damage and threats associated with predators in the State. WS could employ those methods described in Appendix B in an adaptive approach that would integrate methods to reduce damage and threats associated with predators in the State.

Non-lethal methods would be given preference when addressing requests for assistance (see WS Directive 2.101). However, non-lethal methods would not necessarily be employed or recommended to resolve every request for assistance if deemed inappropriate by WS' personnel using the WS Decision Model. For example, if a cooperator requesting assistance had already used non-lethal methods, WS would not likely recommend or continue to employ those particular methods since their use had already been proven ineffective in adequately resolving the damage or threat.

Many non-lethal methods could be used to excluded, harass, and disperse target wildlife from areas where damage or threats were occurring. When effective, non-lethal methods would disperse predators from the area resulting in a reduction in the presence of those predators at the site where those methods were employed. However, predators responsible for causing damage or threats would be dispersed to other areas with minimal impact on those species' populations. Non-lethal methods are not employed over large geographical areas or applied at such intensity that essential resources (*e.g*., food sources, habitat) would be unavailable for extended durations or over a wide geographical scope that long-term adverse effects would occur to a species' population. Non-lethal methods are generally regarded as having minimal impacts on overall populations of wildlife since individuals of those species are not lethally removed. The use of non-lethal methods would not likely have adverse impacts on predator populations in Oklahoma under any of the alternatives.

Lethal methods would also be available for use by WS and/or other entities under all of the alternatives. The use of lethal methods could result in local population reductions in the area where damage or threats were occurring since predators would be removed from the population. The number of predators removed by WS from the population using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of predators involved with the associated damage or threat, and the efficacy of methods employed.

The WS program, the ODAFF, and the ODWC would monitor activities by comparing the number of animals killed from a species with the overall populations or trends in a species' population to assure the magnitude of removal was maintained below the level that would cause undesired adverse effects to the viability the populations. As indicated previously, most requests for assistance received by the WS program in Oklahoma are associated with badgers, bobcats, coyotes, feral/free-ranging cats, feral/free-ranging dogs, gray fox, raccoons, red fox, river otters, striped skunks, and Virginia opossum. In addition to those species, WS occasionally receives requests for assistance or anticipates receiving requests for assistance to manage damage and threats of damage associated with black bears, hog-nosed skunks, long-tailed weasels, mink, mountain lions, ringtails, spotted skunks, and swift fox.

The potential impacts on the populations of target predator species from the implementation of this alternative are analyzed in the following sections.

BADGER POPULATION INFORMATION AND EFFECTS ANALYSIS

Badgers prey heavily on fossorial species; therefore, their range and densities often fluctuate based on prey availability and the soil types. Badgers often avoid extremely rocky soils or soil types that prevent digging (Messick 1987, Lindzey 2003).

The population of badgers in the State is currently unknown; however, Badgers can occur statewide in Oklahoma but may be more common in the western portion of the State (Messick 1987, Lindzey 2003). The population in Oklahoma appears to be stable (J. Davis, ODWC pers. comm. 2016). No density estimates were available for badgers in Oklahoma. Therefore, this analysis will use the best available information to estimate a statewide population. Lindzey (1971) estimated that the Curlew Valley on the Utah-Idaho border supported one badger per square mile and Messick and Hornocker (1981) found 13 badgers per square mile in southwestern Idaho. Badger densities can vary locally in response to prey concentration, with reports of densities between one per 120 to one per 500 acres (0.5 and 2 badgers per square kilometer) (Long and Henke 2004). For purposes of this analysis, the population estimate was derived using the low-density estimate of one badger per square mile. The land area of Oklahoma is approximately 68,600 square miles; therefore, if badgers only occupied 50% of the State (34,300 square miles), under a worst-case scenario, and using the average density of one badger per square mile, the statewide population could be 34,300 badgers. This would be a worst-case scenario since badger populations are likely to inhabit a much larger portion of the State. Similar to estimates derived for the other mammal species addressed in this EA, estimating that badgers inhabit only 50% of certain land classifications in the State is intended to determine a minimum population estimate to compare the potential effects of WS' proposed removal of badgers and to determine the magnitude of WS' proposed removal.

Badgers are furbearing animals in Oklahoma with a regulated harvest season (ODWC 2016*b*). The ODWC places no limit on the number of badgers that people can harvest during the open harvest season. Between 2012 and 2016, the highest number of badger pelts sold at auctions in the State occurred in 2012, when people sold 99 pelts (ODWC 2016*c*). The actual number of badgers harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. Therefore, harvest estimates likely represent a value that deviates from the actual harvest. The harvest information for furbearing animals based on annual fur sales is currently the best available information (J. Davis, ODWC pers. comm. 2016).

The WS program in Oklahoma occasionally receives requests for assistance associated with badgers. Requests for assistance are primarily associated with the digging behavior of badgers. Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 70 technical assistance projects involving badgers. From FY 2009 through FY 2016, WS lethally removed 77 badgers in Oklahoma, which is an annual average removal of 10 badgers. Between FY 2009 and FY 2016, WS intentionally live-captured two badgers and released/relocated those badgers. In addition, the WS program unintentionally removed five badgers during other damage management activities between FY 2009 and FY 2016.

Based upon additional efforts that could occur, WS could kill up to 50 badgers each year to address damage or threats of damage. Removal of up to 50 badgers by WS would represent 0.2% of the estimated statewide population of 34,300 badgers in Oklahoma. WS could also lethally remove badgers unintentionally during other damage management activities; however, WS does not anticipate the cumulative lethal removal of badgers to exceed 50 badgers annually. As discussed previously, between 2012 and 2016, the highest number of badger pelts sold at auctions in the State was 99 pelts (ODWC 2016*c*). If the number of badger pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, if WS' annual removal reached 50 badgers, would represent 0.4% of a statewide population estimated at 30,400 badgers. Although the number of badgers that people harvest in the State is unknown, the cumulative harvest of badgers is not likely to reach a magnitude where population declines would occur. Badger populations may safely sustain an annual harvest rate of 30 to 40% annually (Boddicker 1980).

Activities conducted under this alternative would target individual badgers or local populations of badgers at sites where they were causing damage to agriculture, human health or safety, natural resources, or property. Those activities to reduce specific damage could temporarily reduce some local populations. However, the unlimited harvest levels allowed by the ODWC during the harvest season provides an indication that badger densities within the State are sufficient that overharvest from the harvest season and activities to alleviate damage would not likely occur. The annual removal of badgers by WS would be of low magnitude compared to the actual statewide population in the State. Therefore, the activities of WS to alleviate badger damage or threats of damage would not limit the ability of people to harvest badgers in the State.

BOBCAT POPULATION INFORMATION AND EFFECTS ANALYSIS

The bobcat is a medium-sized member of the North American cat family that people sometimes mistake for a large bob-tailed domestic cat. Bobcats are actually two to three times larger than most domestic cats and appear more muscular and fuller in body. Bobcats are capable of hunting and killing prey that range from the size of a mouse to that of a deer. Rabbits, tree squirrels, ground squirrels, wood rats, porcupines, pocket gophers, and woodchucks comprise most of their diet. Bobcats also prey upon opossums, raccoon, grouse, wild turkey, and other ground nesting birds. Occasionally, insects and reptiles can be part of a bobcat's diet. They also resort to scavenging. Bobcats are opportunistic predators, and may feed on livestock and domestic animals, such as poultry, sheep, goats, house cats, small dogs, exotic birds and game animals, and rarely, calves (Virchow and Hogeland 1994). Anderson and Lovallo (2003) reported the cottontail rabbit to be the principal prey of bobcats throughout their range.

Ruell et al. (2009) reported bobcat densities ranged from 0.65 to 1.09 bobcats per square mile (0.25 to 0.42 bobcats per km^2) in coastal southern California in both large open habitat and in habitat surrounded by human development. Lawhead (1984) reported bobcat densities of 0.66 per square mile (0.26 bobcats per km^2) in Arizona with a preference for riparian habitat. Nielsen and Woolf (2001) reported the bobcat density in southern Illinois was 0.70 bobcats per square mile (0.27 bobcats per km^2). Bobcats reach densities of approximately four bobcats per square mile (0.4 bobcats per km^2) on some islands in the Gulf Coast of the southeastern United States. Bobcat densities stabilized at 0.8 bobcats per square mile during bobcat reintroduction efforts on an island off the coast of Georgia (Diefenbach et al. 2006). Densities vary from about two per square mile (0.8 bobcats per km^2) in coastal plains to about 0.3 bobcats per square mile (0.1 bobcat per km^2) in portions of the Appalachian foothills. Mid-Atlantic and Midwestern states usually have scarce populations of bobcats (Virchow and Hogeland 1994). Rates of natural mortality reported for adult bobcats in protected populations appear to be quite low. Crowe (1975) estimated a 3% mortality rate in a protected population, based on a study of bobcats by Bailey (1972) in southeastern Idaho. Causes of natural mortality for adult bobcats include starvation (Hamilton 1982), disease and predation (Lembeck 1978), and injuries inflicted by prey (Fuller et al. 1985).

Bobcats are present statewide and found in a variety of habitats that can range from coniferous forests to mixed forests to grasslands to Cypress swamps (Rolley and Warde 1985, ODWC 2011*a*). However, the statewide population of bobcats is unknown. Surveys indicate that bobcat populations, although fluctuating, are likely stable and slightly increasing over previous years (J. Davis, pers. Comm. 2016). Bobcats are both a game animal and a furbearing animal in Oklahoma that people with an appropriate license can harvest during annual hunting and trapping seasons (ODWC 2016*b*). The ODWC currently allows people with the appropriate license to harvest 20 bobcats during the length of the harvest season in the State. People who harvest bobcats must report their harvest to the ODWC and people must place a tag from the ODWC on the pelt. During the 2015-2016 hunting and trapping season, the ODWC tagged 2,990 bobcat pelts (J. Davis, ODWC pers. comm. 2016).

WS conducted 183 technical assistance projects from FY 2009 through FY 2016 associated with damage or threats caused by bobcats. The requests for assistance ranged from agriculture predation damage to livestock and poultry, to disease and rabies concerns. From FY 2009 through FY 2016, WS intentionally removed 113 bobcats, during direct operational assistance, to stop or reduce damage and damage threats. During the same eight-year period, WS removed 13 bobcats unintentionally during activities that were targeting other animals. In anticipation of additional efforts by WS to alleviate damage, WS could remove up to 50 bobcats annually in Oklahoma as part of efforts to manage damage to resources and threats to human health and safety, including bobcats that WS' personnel may unintentionally remove during activities targeting other species.

As stated previously, the ODWC tagged 2,990 bobcat pelts during the 2015-2016 season. If the number of bobcats tagged during the 2015-2016 harvest season were representative of future harvest, the lethal removal of up to 50 bobcats by WS would represent 1.7% of the annual harvest of bobcats. Activities conducted under this alternative would target individual bobcats or local populations of bobcats at sites where they were causing damage to agriculture, human health or safety, natural resources, or property. Those activities to reduce specific damage could temporarily reduce some local populations. The annual removal of bobcats by WS would be of low magnitude compared to the actual statewide population in the State. In addition, the magnitude of WS' lethal removal would be low when compared to the annual harvest of bobcats in the State. Therefore, the activities of WS to alleviate bobcat damage or threats of damage would not limit the ability of people to harvest bobcats in the State. WS has reviewed the bobcat management plan for Oklahoma (Mouser and Schofield 2015) and the activities that WS could conduct would be consistent with the plan.

COYOTE POPULATION INFORMATION AND EFFECTS ANALYSIS

Coyotes are a familiar mammal to most people. Their coloration is blended, primarily gray mixed with a reddish tint. The belly and throat are a paler color than the rest of the body (Bekoff 1982). Coyotes have long, rusty or yellowish legs with dark vertical lines on the lower foreleg. They are similar in appearance to gray and red wolves (Bekoff and Gese 2003). Color varies from nearly black to red or nearly white in some individuals and local populations. Most have dark or black guard hairs over their back and tail (Green et al. 1994). They sometimes breed with domestic dogs (Bekoff and Gese 2003). Coyotes often include many items in their diet. Rabbits are one of the most common prey species. Other items in the coyote's diet include carrion, rodents, deer (usually fawns), insects (such as grasshoppers), as well as livestock and poultry. Coyotes readily eat fruits, such as watermelons, berries, persimmons, and other vegetative matter when it is available. In some areas, coyotes feed on human refuse at dumpsites and prey on small domestic pets, such as cats and dogs (Voigt and Berg 1987).

Coyotes are highly mobile animals with home ranges (territories) that vary by sex and age of the animal, food abundance, habitat, and season of the year (Pyrah 1984, Bekoff and Gese 2003). Coyote populations are comprised of territorial and non-territorial individuals. Each territory contains a dominant pair, associated subordinates, and pups. Pre-whelping pack size ranges from two to 10 individuals (Gese et al. 1996, Knowlton et al. 1999). Coyotes breed between January and March and are able to breed prior to reaching one year of age (Kennelly and Johns 1976), but the percentage of yearlings having litters varies from zero to 80% in different populations (Gier 1968). This variation is influenced by a number of factors causing large annual variations in total number of coyotes breeding. In a Texas study, the percentage of females having litters varied from 48% to 81% (Knowlton 1972). Pups are born after a gestation period of 60 to 63 days, with litter sizes varying primarily with prey availability. Each dominant pair can produce a single litter of four to eight pups (Knowlton 1972, Gese et al. 1996). Gier

(1968) reported average litter sizes of 4.8 to 5.1 in years with low rodent numbers, but litters of 5.8 to 6.2 during years with high rodent numbers.

Many references indicate that coyotes originally occurred in relatively open habitats, particularly grasslands and sparsely wooded areas of the western United States. The distribution of coyotes in eastern North America began to expand from 1900 to 1920. Now, all eastern states and Canadian provinces have at least a small population of coyotes (Voigt and Berg 1987). Today, coyotes range throughout the United States. Coyotes have adapted to, and now exist in virtually every type of habitat, arctic to tropic, in North America. Coyotes live in deserts, swamps, tundra, grasslands, brush, dense forests, from below sea level to high mountain ranges, and at all intermediate altitudes. High densities of coyotes also appear in the suburbs of major cities (Green et al. 1994).

The coyote is probably the most extensively studied carnivore (Bekoff and Gese 2003), and considerable research has been conducted on population dynamics. However, methods for estimating carnivore populations are crude and often produce estimates with broad confidence intervals (Crawford et al. 1993). Because determinations of absolute coyote densities are frequently unknown (Knowlton 1972), many researchers have estimated coyote populations using various methods (Clark 1972, Knowlton 1972, Camenzind 1978, Pyrah 1984, Knowlton et al. 1999). The cost to determine absolute coyote densities accurately over large areas is prohibitive (Connolly 1992) and the cost would not appear to be warranted given the coyote's overall relative abundance. The presence of unusual food concentrations and the assistance provided to a breeding pair by non-breeding coyotes at the den can influence coyote densities and complicate efforts to estimate abundance (Danner and Smith 1980). Coyote densities are lowest in late winter prior to whelping, highest immediately after whelping, followed by a continued decline to the next whelping season (Parker 1995, Knowlton et al. 1999). Each occupied coyote territory may have several nonbreeding helpers at the den during whelping (Allen et al. 1987). Therefore, each defended coyote territory may have more than just a pair of coyotes. Messier and Barrette (1982) reported that from November through April, 35% of the coyotes were in groups of three to five animals and Gese et al. (1988) reported that coyote groups of 2, 3, 4, and 5 individuals comprised 40%, 37%, 10%, and 6% of the resident population, respectively.

Predator abundance indices suggest that densities of coyotes in North America increase from north to south (Knowlton and Stoddart 1985, Parker 1995, Knowlton et al. 1999). Coyote densities can vary considerably between habitat types and vary based on numerous environmental variables. Coyote densities can range from 0.5 coyotes per square mile to six coyotes per square mile (Voigt and Berg 1987, Knowlton et al. 1999, Bekoff and Gese 2003). Knowlton (1972) concluded that coyote densities might approach a high of five to six coyotes per square mile under extremely favorable conditions. Such an estimate is speculative but represents some of the best available information for estimating coyote populations.

The unique resilience of the coyote, its ability to adapt, and its perseverance under adverse conditions is commonly recognized among biologists and land managers. Despite intensive historical damage management efforts in livestock production areas and despite sport hunting and trapping for fur, coyotes continue to thrive and expand their range, occurring widely across North and Central America (Connolly 1978, Miller 1995, Gese et al. 2008). While removing animals from small areas at the appropriate time can protect vulnerable livestock, immigration of coyotes from the surrounding area can quickly replace the animals removed (Stoddart 1984, Windberg and Knowlton 1988). Compensatory reproduction and mortality factors also contribute to rapid population recovery after removals and the ability of coyote populations to sustain relatively high levels of removals over time. A population model by Pitt et al. (2001, 2003) assessed the impact of removing a set proportion of a coyote population during one year and then allowing the population to recover. In the model, all populations recovered within one year when <60% of the population was removed. Recovery occurred within five years when removal reached 60 to

90% of the population. Pitt et al. (2001, 2003) also evaluated the impact of removing a set proportion of the population every year for 50 years. When the removal rate was <60% of the population, the population size was the same as for an unexploited population. These findings are consistent with an earlier model developed by Connolly and Longhurst (1975) and revisited by Connolly (1995), which indicated that coyote populations could withstand an annual removal of up to 70% of their numbers and still maintain a viable population.

Actual population or density estimates for coyotes in Oklahoma are not available. Coyotes are common throughout the State and inhabit a variety of habitats. Surveys conducted and fur sales have shown a stable to slightly increasing coyote population in Oklahoma (J. Davis, ODWC pers. comm. 2016). If coyotes only occupy 50% of the land area within the State, and the density of coyotes in the State ranges from 0.5 coyotes per square mile to five coyotes per square mile, the statewide population would be from 17,200 coyotes to a high of 171,500 coyotes. Coyotes are both a game animal and a furbearing animal in Oklahoma with a continuous open harvest season and no limit on the number of coyotes that people can harvest (ODWC 2016*b*). During 2016, people sold 260 coyotes pelts at fur auctions within the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of coyote pelts sold at auctions in the State occurred in 2012, when people sold 1,244 pelts (ODWC 2016*c*). The actual number of coyotes harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. With a continuous open season and with no limit on the number of coyotes that people can harvest, it is unknown how many coyotes that people actually remove during a year to alleviate damage.

Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 3,273 technical assistance projects associated with damage and threats of damages caused by coyotes, which includes those projects where WS provided information on managing damage or threats caused by coyotes. Requests for assistance were primarily associated with threats to human safety and predation of livestock and poultry. WS also provided direct operational assistance associated with coyotes from FY 2009 through FY 2016. During direct operational assistance projects, WS lethally removed 46,233 coyotes from FY 2009 through FY 2016, which is an average annual removal of 5,779 coyotes. In addition, WS dispersed 56 coyotes to alleviate the threat of damage between FY 2009 and FY 2016.

Based upon additional efforts that could occur, WS could kill up to 8,000 coyotes each year to address damage or threats of damage. Removal of up to 8,000 coyotes by WS would represent 4.7% of the estimated statewide population of 171,500 coyotes in Oklahoma. As discussed previously, between 2012 and 2016, the highest number of coyote pelts sold at auctions in the State was 1,244 pelts (ODWC 2016*c*). If the number of coyote pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, if WS' annual removal reached 8,000 coyotes, would represent 5.4% of a statewide population estimated at 171,500 coyotes. Removal of 5.4% of the estimated population would be below the 60% removal level required to cause population declines calculated by Pitt et al. (2001, 2003). Even if the coyote density in the State was only one coyote per square mile and coyotes only occupied 50% of the land area of the State, the cumulative remove of coyotes would be 27.0% of the statewide population, which would continue to be less than the 60% harvest level required to cause a population decline. Although the number of coyotes that people harvest in the State is unknown, the cumulative harvest of coyotes is not likely to reach a magnitude where population declines would occur. The International Union for Conservation of Nature and Natural Resources stated, "*Coyotes are abundant throughout their range and are increasing in distribution*…" and "*Local control temporarily reduces numbers on a short-term basis, but coyote populations generally are stable in most areas*" (Gese et al. 2008).

Although exact population estimates for coyotes in Oklahoma and annual removal rates are not available, the unlimited harvest allowed by the ODWC for the species and the continuous open season indicates the species is not at risk of overharvesting. Since the statewide population could reasonably be expected to be higher than 171,500 coyotes, the proposed removal of 8,000 coyotes annually and the cumulative harvest of coyotes would actually be a smaller percentage of the actual statewide population. The annual removal of coyotes by WS would be of low magnitude compared to the actual statewide population. Therefore, the activities of WS to alleviate coyote damage or threats of damage would not limit the ability of people to harvest coyotes in the State.

FERAL AND FREE-RANGING CAT POPULATION INFORMATION AND EFFECTS ANALYSIS

Feral cats and free-ranging cats are domesticated cats living in the wild or allowed to range freely in the wild. They are generally small in stature, weighing from three to eight pounds (1.4 to 3.6 kg), standing eight to 12 inches (20 to 30.5 cm) high at the shoulder, and 14 to 24 inches (35.5 to 61 cm) long. The tail adds another 20 to 30.5 cm (8 to 12 inches) to their length. Colors range from black to white to orange, and a variety of combinations of those colors. Other hair characteristics also vary greatly (Fitzwater 1994).

Feral and free-ranging cats can occur in commensal relationships wherever people occur. In some urban and suburban areas, cat populations can equal human populations. In many suburban and rural areas, feral cats may be the most abundant predators. They are opportunistic predators and scavengers that feed on rodents, rabbits, shrews, moles, birds, insects, reptiles, amphibians, fish, carrion, garbage, vegetation, and leftover pet food (Fitzwater 1994).

Feral cats can produce two to 10 kittens during any month of the year. An adult female may produce three litters per year where food and habitat are sufficient. Cats may be active during the day but typically are more active during twilight or at night. House cats may live up to 27 years, but feral and free-ranging cats probably average only three to five years. They are territorial and move within a home range of roughly four km^2 (1.5 mi^2). After several generations, feral cats are wild in habits and temperament (Fitzwater 1994).

Feral and free-ranging cats can have an impact on wildlife populations in suburban and rural areas directly by predation and indirectly by competition for food (Coleman and Temple 1989). In the United Kingdom, one study determined that house cats might take an annual toll of some 70 million animals and birds (Churcher and Lawton 1987). American birds face an estimated 117 to 157 million exotic predators in the form of free-ranging domestic cats, which may kill at least one billion birds every year in the United States. Cats have contributed to declines and extinctions of birds worldwide, with feral cats considered one of the most important drivers of global bird extinctions (Dauphine and Cooper 2009).

Feral and free-ranging cats also pose a health and safety threat to household pets. Feral and stray cats are at increased risk of feline immunodeficiency virus, feline leukemia, feline panleukopenia virus, also known as feline distemper, and rabies. Feral and free-ranging cats can transmit all of those diseases to unvaccinated pet owners allow their cats to free-range. The feline panleukopenia virus is highly contagious and the virus may survive in the environment for up to a year. In addition, people can transmit the virus to indoor cats through indirect routes, such as on shoes (Berthier et al. 2000, Truyen et al. 2009). Feral and free-ranging cats can serve as a reservoir for animal and human diseases, including cat scratch fever, histoplasmosis, leptospirosis, mumps, plague, rabies, ringworm, salmonellosis, toxoplasmosis, tularemia, and various parasites (Fitzwater 1994).

The number of feral cats in Oklahoma is unknown. Feral and free-ranging cats are considered by many wildlife biologists and ornithologists to be a detriment to native wildlife species. Feral cats prey upon native wildlife species and compete with native predators for prey. Thus, removing feral cats could be considered as providing some benefit to the natural environment by eliminating predation and competition from an introduced species.

Requests for assistance received by the WS program in Oklahoma involving feral or free-ranging cats have primarily been associated with human safety threats and damage to property. Between FY 2009 and FY 2016, the WS program provided technical assistance involving feral or free-ranging cats during 19 projects. During direct operational assistance projects conducted by WS, WS lethally removed 197 feral or free-ranging cats intentionally to alleviate damage or threats of damage from FY 2009 through FY 2016, which is an average removal of 25 feral or free-ranging cats per year. In addition, WS live-captured and released unharmed, transferred custody, and/or dispersed five feral or free-ranging cats intentionally. WS also lethally removed one feral cat unintentionally between FY 2009 and FY 2016 during activities targeting other animals.

In populated areas, WS would employ live-capture methods to alleviate damage or threats of damage associated with feral or free-ranging cats. Once live-captured, WS would transfer custody of the cats to a local animal control facility. After relinquishing the feral or free-ranging cats to a local animal control facility, the care and the final disposition of the cat would be the responsibility of the animal control facility. However, in some cases, WS may be requested to remove feral cats to alleviate damage or threats. In anticipation of WS receiving requests to remove feral cats, up to 100 feral or free-ranging cats could be lethally removed by WS annually. Feral cats could also be lethally removed unintentionally during other damage management activities; however, WS does not anticipate the cumulative lethal removal of feral cats to exceed 100 cats annually. Based upon the above information, WS' limited removal of feral cats would have minimal effects on local or statewide populations in Oklahoma. Some local populations may be temporarily reduced at a local site if cats were removed using non-lethal or lethal methods. In those cases where feral cats were causing damage or were creating a nuisance and complete removal of the local population could be achieved, this could be considered as providing some benefit to the natural environment since feral cats are not considered part of the native ecosystem.

FERAL AND FREE-RANGING DOG POPULATION INFORMATION AND EFFECTS ANALYSIS

Like domestic dogs, feral and free-ranging dogs can manifest themselves in a variety of shapes, sizes, colors, and even breeds. McKnight (1964) noted German shepherds, Doberman pinschers, and collies as breeds that often become feral. Most feral dogs today are descendants of domestic dogs that appear similar to dog breeds that are locally common (Green and Gipson 1994). The primary feature that distinguishes feral from domestic dogs is the degree of reliance or dependence on people, and in some respect, their behavior toward people. Feral dogs survive and reproduce independently of human intervention or assistance. While it is true that some feral and free-ranging dogs use human garbage for food, others acquire their primary subsistence by hunting and scavenging like other wild canids.

Feral and domestic dogs often differ markedly in their behavior toward people. Scott and Causey (1973) based their classification of those two types by observing the behavior of dogs while confined in cage traps. Domestic dogs usually wagged their tails or exhibited a calm disposition when people approached; whereas, most feral dogs showed highly aggressive behavior, growling, barking, and attempting to bite. Some dogs were intermediate in their behavior and Scott and Causey (1973) could not classify those dogs as either feral or domestic based solely on their reaction to people. The aggressive behavior of feral dogs toward people is not surprising since people have pursued, shot at, or trapped many feral dogs. For example, a feral dog caught in Arkansas had numerous lead pellets imbedded under the skin, which Gipson (1983) indicated was likely a testament to the relationship between some people and feral dogs.

Feral dogs are usually secretive and wary of people. Thus, they are active during dawn, dusk, and at night, much like other wild canids. They often travel in packs or groups and may have rendezvous sites, similar to wolves. Travel routes to and from gathering sites or den sites may be well defined. Food scraps and other evidence of concentrated activity may occur at gathering sites.

The appearance of tracks left by feral and free-ranging dogs varies with the size and weight of the animal. Generally, dog tracks are more round and show more prominent nail marks than those of coyotes, and they are usually larger than the tracks of fox. Since a pack of feral dogs likely consists of animals in a variety of sizes and shapes, the tracks from a pack of dogs will vary correspondingly, unlike the tracks of a group of coyotes (Green and Gipson 1994).

Feral and free-ranging dogs may occur where people permit their dogs to roam free or where people abandon unwanted dogs. Feral and free-ranging dogs probably occur in all of the 50 states, Canada, and Central and South America. They are also common in Europe, Australia, Africa, and on several remote ocean islands, such as the Galapagos. Home ranges of feral and free-ranging dogs vary considerably in size, with size likely influenced by the availability of food. Dog packs that are primarily dependent on garbage may remain in the immediate vicinity of a landfill, while other packs that depend on livestock or wild game may forage over an area of 130 km^2 (50 mi^2) or more (Green and Gipson 1994).

Some people will not tolerate feral dogs in close proximity to human activity; thus, they take considerable effort to eliminate them in such areas. Feral dogs occur on lands where human access is limited, such as military reservations and large airports. They may also live in remote sites, where they feed on wildlife and native fruits. The only areas that do not appear to be suitable for feral dogs are places where food and escape cover are not available, or where large native carnivores, particularly wolves, are common and prey on dogs (Green and Gipson 1994).

Like coyotes, feral and free-ranging dogs are opportunistic feeders. They can be efficient predators, preying on small and large animals, including domestic livestock. Many rely on carrion, particularly road-killed animals, crippled waterfowl, green vegetation, berries, and other fruits, and refuse at garbage dumps (Green and Gipson 1994).

Feral and free-ranging dogs are highly adaptable, social carnivores. Gipson (1983) suggested that family groups of feral and free-ranging dogs are more highly organized than previously believed. Several members of a pack may share pup rearing. Pups born during autumn and winter often survive, even in areas with harsh winter weather. Gipson (1983) found that only one female in a pack of feral dogs studied in Alaska gave birth during two years of study, even though other adult females were present in the pack. The breeding female gave birth during late September or early October during both years. Gipson (1983) indicated that all pups from both litters had similar color markings, suggesting that the pups had the same father. Adult males of different colors were present in the pack.

Nesbitt (1975) commented on the rigid social organization of a pack of feral dogs where nonresident dogs were excluded, including females in estrus. In one instance, Nesbitt (1975) used three separate female dogs in estrus as bait (dogs were chained in the back of a corral-type trap) over a 59-day period and captured no feral dogs. Nesbitt (1975) then baited the same trap with carrion, and a pack of feral dogs, including four adult males, entered the trap within one week (Green and Gipson 1994).

Hybridization between feral dogs and other wild canids can occur, but non-synchronous estrus periods and pack behavior (that is, excluding non-resident canids from membership in the pack) may preclude much interbreeding. Dens may be burrows dug in the ground or sheltered spots under abandoned buildings or farm machinery. Feral dogs commonly use former fox or coyote dens (Green and Gipson 1994).

Feral dogs can cause damage by preying on livestock, poultry, house cats, or domestic dogs. They may also feed on fruit crops including melons, berries, grapes, and native fruit. They may also attack people, especially children. This is especially true where they feed at and live around landfills near human dwellings (Green and Gipson 1994). In some locales, they may present a serious threat to deer (Lowry 1978) and other valuable wildlife (Green and Gipson 1994). In Oklahoma, people can legally remove dogs if people catch those dogs in the act of predation on livestock. There are no reporting requirements for the removal of dogs by the public; therefore, the number of occurrences and the number of dogs removed by other entities is unknown.

The WS program in Oklahoma provided technical assistance to requesters associated with dogs during 86 projects between FY 2009 and FY 2016. Many requests for assistance were referred to a local animal control facility since requesters were usually unable to determine if a dog was feral or a free-ranging pet. In Oklahoma, WS must receive a request for assistance from a law enforcement entity before conducting activities associated with feral dogs. From FY 2009 through FY 2016, WS lethally removed 57 feral dogs intentionally during damage management activities in Oklahoma, which is an average removal of seven feral dogs per year. WS has also live-captured and released or dispersed 90 feral dogs during damage management activities between FY 2009 and FY 2016. WS could also capture or lethally remove feral dogs unintentionally during other damage management activities. From FY 2009 through FY 2016, WS lethally removed 140 dogs unintentionally in the State. In addition, WS captured 35 feral dogs unintentionally but released those dogs unharmed or relinquished those dogs to appropriate authorities.

In populated areas, by direct request for assistance from law enforcement authorities, WS would employ non-lethal harassment methods to disperse feral dogs or WS would employ live-capture methods to alleviate damage or threats of damage associated with dogs. Once live-captured, WS would transfer custody of the dogs to a local animal control facility. After relinquishing the dogs to a local animal control facility, the care and the final disposition of the dog would be the responsibility of the animal control facility.

Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, the WS program in Oklahoma could lethally remove up to 50 feral or free-ranging dogs annually. The WS program could also lethally removed feral dogs unintentionally during activities that target other species; however, WS does not anticipate the cumulative lethal removal of feral dogs to exceed 50 dogs annually. When requested to assist with managing damage caused by feral or free-ranging dogs, WS would comply with WS Directive 2.340. Based upon the above information, WS' limited removal of feral dogs would have minimal effects on local or statewide populations in Oklahoma. Some local populations may be temporarily reduced at a local site if dogs were removed using non-lethal or lethal methods. In those cases where feral dogs were causing damage or were creating a nuisance and complete removal of the local population could be achieved, this could be considered as providing some benefit to the natural environment since feral dogs are not considered part of the native ecosystem.

GRAY FOX POPULATION INFORMATION AND EFFECTS ANALYSIS

The gray fox is common in many parts of the United States where deciduous woodlands provide habitat; yet, the secretive grey fox is seldom observed in the wild. The gray fox is somewhat smaller in stature than the red fox, having shorter legs and extremities. Gray fox exhibit striking pelage, which has grizzled upper parts resulting from individual guard hairs being banded with white, gray, and black. A predominance of black-tipped hairs in the middle of the back forms a dark longitudinal stripe that extends into a conspicuous black mane of coarse hair at the top of the black-tipped tail. Portions of the neck, sides, and limbs are cinnamon-colored. The ventral areas of a gray fox are buff colored. White shows on the ears, throat, chest, belly, and back legs, and the black, white, and reddish facial markings provide distinctive accents (Fritzell 1987).

Gray fox adults weigh from three to seven kilograms (6.5 to 15 lbs), with males being slightly larger than females. Generally, adult gray fox measure 80 to 113 cm (31.5 to 44 inches) from the tip of the nose to the tip of the tail. They inhabit wooded, brushy, and rocky habitats from extreme southern Canada to northern Venezuela and Colombia, excluding portions of the mountainous northwestern United States, the Great Plains, and eastern Central America. Gray fox occur over most of the eastern and southwestern United States along with most of California and western Oregon (Fritzell 1987, Cypher 2003).

Gray fox prefer habitat with dense cover, such as thickets, riparian areas, swampland, or rocky pinyon-cedar ridges. In eastern North America, gray fox are closely associated with edges of deciduous forest. They can also occur in urban areas where suitable habitat exists (Phillips and Schmidt 1994, Cypher 2003).

Gray fox mate from January through April and produce litters of one to ten kits after a gestation period of 53 days (Cypher 2003). Gray fox rear young in a maternity den, commonly located in woodpiles, rocky outcrops, hollow trees, or brush piles (Phillips and Schmidt 1994, Cypher 2003). The male parent helps tend to the young but does not stay in the den with them. The young are weaned at three months and hunt for themselves at four months. Rabies and distemper are associated with this species (Cypher 2003).

Accurate estimates of carnivore populations are rare and those for gray fox populations are no exception. Published estimates of gray fox density vary from 1.2 to 2.1 per km^2 (3.1 to 5.4 per mi^2) depending on location, season, and method of estimation (Errington 1933, Gier 1948, Lord 1961, Trapp 1978). Over areas larger than 5,000 km^2 (1,930 mi^2), in which habitat quality varies, densities are likely lower. However, exceptionally high fox densities have been recorded in some situations (Grinnell et al. 1937, Hallberg and Trapp 1984).

Home ranges for gray fox vary throughout the year. Both males and females travel over larger areas during fall and winter, probably in response to increased energy demands and a declining food base (Follmann 1973, Nicholson 1982). During April, when young fox require regular feeding, a female's home range is less extensive than it is without the demands of those young (Follman 1973). Although exceptions exist, eastern gray fox generally have larger home ranges than western animals (Fritzell 1987). For instance, 16 adult fox were tracked for more than one month in Alabama (Nicholson 1982) and Missouri (Haroldson and Fritzell 1984) and it was determined that they all had home ranges larger than 200 hectares (500 acres), and many exceeded 500 hectares (1,235 acres).

Gray fox feed on a wide variety of plant and animal matter, but feed on a wider variety of plant and animal matter than other North American canids (Fritzell 1987, Cypher 2003). Although active primarily at twilight and at night, the gray fox is sometimes seen foraging by day in brush, thick foliage, or timber. The only American canid with true climbing ability, gray fox occasionally forage in trees and often takes refuge in them, especially leaning or thickly branched trees. The gray fox feeds heavily on cottontail rabbits, mice, voles, other small mammals, birds, insects, and plant material, including corn, apples, persimmons, nuts, cherries, grapes, pokeweed fruit, grass, and blackberries. Grasshoppers and crickets are often a very important part of the diet in late summer and autumn (Cypher 2003).

Given the habitat preferences of gray fox, the most likely land cover types that would support gray fox are deciduous forest, mixed forest, shrub/scrub, and woody wetlands, which are primarily associated with the eastern portion of the State. The land area of Oklahoma is approximately 68,600 square miles; therefore, the eastern half of the State consists of approximately 34,300 square miles. If gray fox only occupied 50% of the eastern portion of the State (17,200 square miles) and the density of gray fox in the State were 3.1 gray fox per square mile of habitat, the statewide population would be approximately 53,300 gray fox. Gray fox occur in a variety of habitats, including urban areas, so gray fox occupying only 50% of the land area is unlikely since gray fox occur throughout the State in suitable habitat. However, similar to the other furbearing species, the analysis estimated that gray fox occupy only 50% of the possible land area to evaluate the magnitude of the proposed removal by WS on a minimal population.

The ODWC is responsible for managing the gray fox population in Oklahoma. The ODWC classifies the gray fox as both a game animal and a furbearing animal in Oklahoma with annual hunting and trapping seasons (ODWC 2016*b*). During the harvest season, people can harvest up to two fox per day. During the length of the season, people can harvest up to six gray fox. During the 2016 season, the total number of gray fox pelts sold at fur auctions in Oklahoma was 34 pelts (ODWC 2016*c*). Between 2012 and 2016, the highest number of gray fox pelts sold at auctions in the State occurred in 2012, when people sold 304 pelts (ODWC 2016*c*). However, the number of gray fox harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal.

Requests for assistance associated with gray fox received by WS have been primarily associated with disease threats, threats to aviation, and predation to poultry and livestock. During direct operational assistance projects, WS lethally removed 21 gray fox, and live-captured and released 8 gray fox as target animals between FY 2009 through FY 2016, with 5 gray fox lethally removed unintentionally during other damage management activities. Cumulatively, the WS program in Oklahoma has lethally removed an average of three gray fox per year between FY 2009 through FY 2016.

Based on previous requests received by WS to reduce damage and in anticipation of additional efforts, WS could remove up to 15 gray fox annually under Alternative 1 to address requests to alleviate damage and threats of damage. WS could also lethally remove gray fox unintentionally during activities targeting other animals; however, WS does not anticipate the cumulative lethal removal of gray fox by WS to exceed 15 fox annually. Using the population estimate of 53,300 fox, the removal of 15 gray fox by WS would represent 0.03% of the estimated statewide population. As discussed previously, between 2012 and 2016, the highest number of gray fox pelts sold at auctions in the State was 304 pelts (ODWC 2016*c*). If the number of gray fox pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, if WS' annual removal reached 15 fox, would represent 0.6% of a statewide population estimated at 53,300 gray fox. Although the number of gray fox that people harvest in the State is unknown, the cumulative harvest of gray fox is not likely to reach a magnitude where population declines would occur.

Since the statewide population of gray fox is likely higher than 53,300 fox, WS' annual removal of gray fox and the cumulative harvest would represent a lower percentage of the actual statewide population. Based on the limited lethal removed that could occur by WS when compared to the estimated statewide population, the activities of WS to alleviate gray fox damage or threats of damage would not limit the ability of people to harvest fox in the State. In addition, surveys conducted have shown the population of gray fox in Oklahoma to be stable (J. Davis, ODWC pers. comm. 2016).

MINK POPULATION INFORMATION AND EFFECTS ANALYSIS

Mink are a member of the weasel family and are about 46 to 61 centimeters (18 to 24 inches) in length, including the somewhat bushy tail. These animals weigh about 0.7 to 1.4 kilograms (1.5 to 3 lbs). Females are about three-fourths the size of males. Both sexes are a rich chocolate-brown color, usually with a white patch on the chest or chin, and scattered white patches on the belly. The fur is relatively short with the coat consisting of a soft, dense under-fur concealed by glossy, lustrous guard hairs. Mink also have anal musk glands common to the weasel family, and can discharge a disagreeable musk if frightened or disturbed (Boggess 1994*a*). They also mark their hunting territory with this fetid musk, which is as malodorous as a skunk's musk, although it does not carry as far (National Audubon Society 2000).

Mink occur throughout North America, with the exception of the desert southwest and tundra areas (Eagle and Whitman 1987, Larivière 2003). They are shoreline dwellers and their one basic habitat requirement is a suitable permanent water area. This may be a stream, river, pond, marsh, swamp, or lake. Mink often make their dens in bank burrows, holes, crevices, logjams, and abandoned muskrat houses or beaver lodges. They are active mainly at night and are active throughout the year, except for brief intervals during periods of low temperature or heavy snow (Boggess 1994*a*, Larivière 2003). However, they may adjust hunting times to prey availability (Larivière 2003).

Eagle and Whitman (1987) indicated mink population densities varied spatially based on habitat, and weather, trapping, and intraspecific aggression can influence densities temporally. Generally, densities of mink are highest in those areas with abundant, stable aquatic habitat. In Louisiana, Linscombe et al. (1982) found mink densities were highest in swamps, followed by marshes, and drained bottomlands. In Montana, Mitchell (1961) estimated that 280 mink inhabited a 33 square kilometer (12.8 mi^2) area, resulting in a density of one mink per 11.8 ha (29.2 acres). However, the following year, Mitchell (1961) estimated that there were only 109 mink in the area, a density of one mink per 30.3 hectare (74.7 acres). Using mink tracks in snow, Marshall (1936) found 0.6 females in one square kilometer (1.5/mi^2) of riverbank with a 1:1 sex ratio following heavy trapping in Michigan. Errington (1943) found one to five mink families occupying a 180-hectare (450 acres) marsh in Iowa from 1933 to 1938. In 1939, Errington (1943) found no families in the same marsh. Errington (1943) suggested that over-trapping was responsible for the low numbers. Errington (1943) also suggested that intraspecific aggression was responsible for the upper limit of mink inhabiting the marsh.

At a refuge in Wisconsin, McCabe (1949) estimated 24 mink inhabited 446 hectares (1,100 acres) in 1944, which resulted in a density of one mink per 18.8 hectare (46.3 acres). Over the next four years (1945 to 1948), McCabe (1949) found the number of mink ranged from seven to 10 individuals at the refuge. McCabe (1949) also suggested that the lower population estimates found after the initial year of the study in 1944 were due to higher levels of mink trapping and excessive poaching along the refuge borders. The number of mink observed during the study conducted by McCabe (1949) at the refuge was inversely related to the duration and depth of snow cover; however, the number observed was poorly related to food availability (rabbits [*Sylvilagus* spp.] and mice [*Peromyscus* spp.]). During a two-year study in Sweden, Gerell (1971) estimated the number of mink present in a 10,000-hectare (25,000 acres) area at 11 and 16 mink, respectively, which resulted in a density of one mink per 909 hectares (2,245 acres) during the first year of the study and one mink per 625 hectare (1,545 acres) in the second year. Along 1.9 kilometers (1.2 miles) of stream in British Columbia, Ritcey and Edwards (1956) caught 11, six, and five mink over three years, respectively, which were similar densities of 1.5 to 3 mink per kilometer (2.5 to 5 mink per mile) found along the coastal shoreline on Vancouver Island reported by Hatler (1976).

The population of mink in the State is currently unknown; however, mink occur statewide in Oklahoma usually near permanent water sources, such as wetland habitats and streams, rivers, and lakes (ODWC 2011*b*). Surveys conducted indicate that mink populations are stable in Oklahoma (J. Davis, ODWC pers. comm. 2016). Mink are secretive; however, they are common in many parts of Oklahoma. No population estimates or density estimates were available for mink in Oklahoma. Therefore, this analysis will use the best available information to estimate a statewide population. There are approximately 167,600 miles of perennial and intermittent streams and rivers and 55,646 miles of shoreline along lakes and ponds in Oklahoma (Oklahoma Water Resources Board 2016), with 950,000 acres of wetlands (United States Geological Survey 1996, Association of State Wetland Managers 2013). If only 50% of the 950,000 acres of wetlands (lowest estimate) present in the State supported mink and if the population density of mink in the State was one mink per 74.7 acres, the number of mink inhabiting wetlands in the State would be 6,359 mink. If only 50% of the 167,600 miles of streams in the State supported mink and if the population density of mink were only one mink per one mile of stream, the population inhabiting shoreline would be approximately 83,800 mink. Combining the number of mink inhabiting wetlands and streams, the total statewide mink population would be approximately 90,200 mink.

Mink are furbearing animals in Oklahoma with a regulated trapping season (ODWC 2016*b*). The ODWC places no limit on the number of mink that people can harvest during the open trapping season. In 2016, people sold three mink pelts at fur auctions in the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of mink pelts sold at auctions in the State occurred in 2012, when people sold 15 pelts (ODWC 2016*c*). As discussed previously, the actual number of mink harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal.

WS lethally removed one mink to alleviate damage from FY 2009 through FY 2016. Based upon additional efforts that could occur, WS could kill up to five mink each year to address damage or threats of damage. Removal of up to five mink by WS would represent 0.01% of the estimated statewide population of 90,200 mink in Oklahoma. WS could also lethally remove mink unintentionally during other damage management activities; however, WS does not anticipate the cumulative lethal removal of mink to exceed five mink annually. As discussed previously, between 2012 and 2016, the highest number of mink pelts sold at auctions in the State was 15 pelts (ODWC 2016*c*). If the number of mink pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by trappers and WS, if WS' annual removal reached five mink, would represent 0.02% of a statewide population estimated at 90,200 mink. Although the number of mink that people harvest in the State is unknown, the cumulative harvest of mink is not likely to reach a magnitude where population declines would occur.

Activities conducted under this alternative would target individual mink or local populations of mink at sites where they were causing damage to agriculture, human health or safety, natural resources, or property. Those activities to reduce specific damage could temporarily reduce some local populations. However, the unlimited harvest levels allowed by the ODWC during the trapping season provides an indication that mink densities within the State are sufficient that overharvest from the trapping season and activities to alleviate damage would not likely occur. The annual removal of mink by WS would be of low magnitude compared to the actual statewide population in the State. Therefore, the activities of WS to alleviate mink damage or threats of damage would not limit the ability of people to harvest mink in the State.

MOUNTAIN LION POPULATION INFORMATION AND EFFECTS ANALYSIS

The mountain lion, also known as the cougar, ranks among the most elusive and discussed of all the wildlife species in Oklahoma. Several characteristics distinguish the mountain lion from other similar species. For example, its tail is more than half the length of the body and it has black tips on the tail and ears. Mountain lions are primarily tan in color. The size of mountain lions varies by sex. Males average seven feet long (from nose to the tip of its tail) and weigh around 140 pounds, while females average six feet in length with a body weight around 95 pounds (ODWC 2011*c*).

The WS program rarely verifies reported sightings of mountain lions as actually being mountain lions. People often mistake domestic cats, bobcats, and coyotes as mountain lions. The best habitat and area for the occurrence of mountain lions in Oklahoma is the Rolling Red Plains ecoregion, which occurs in far western Oklahoma. Approximately 60% of this region is rangeland that consists of large blocks of private land holdings with a low human population density, which can be ideal habitat for mountain lions (ODWC 2011*c*). Mountain lions may move into and out of the State along major waterways from New Mexico, Colorado, and the Texas panhandle. Most mountain lions entering Oklahoma are young males searching for new territories (ODWC 2011*c*). No known reproduction of mountain lions has occurred within the State of Oklahoma. Recent confirmations would suggest that frequency of transient mountain lions is slightly increasing over the past years (J. Davis, ODWC pers. comm. 2016).

Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 105 technical assistance projects involving mountain lions. Most requests for assistance involved livestock predation and human safety concerns. WS anticipates continuing to address most requests for assistance associated with mountain lions by providing technical assistance. In accordance with an MOU with the ODWC, the WS program in Oklahoma can lethally remove mountain lions in Oklahoma when there is a verified predation loss. If a confirmed mountain lion predation occurs, WS would communicate and confer with the ODWC before conducting activities. In addition, WS would provide the ODWC with any data and specimens collected during activities that could contribute to mountain lion research and conservation efforts conducted by the ODWC. WS removed one mountain lion in Oklahoma between FY 2009 through FY 2016. The mountain lion was intentionally removed after verify predation on livestock. The removal of mountain lions by WS in the State would occur infrequently and would likely be limited to one or two individuals on an infrequent basis.

In addition, the ODWC would continue to monitor activities conducted by WS to ensure activities occurred within management objectives established by the ODWC. Based on the limited removal proposed by WS and the oversight by the ODWC, WS' infrequent removal of mountain lions would have no effect on the population in the State. In addition, if WS implemented this alternative, the WS program in Oklahoma would monitor activities conducted to ensure program activities continue to occur within the impact parameters evaluated in the EA. Through the review of activities and through consultation with the ODWC, the WS program in Oklahoma can evaluate and adjust activities conducted. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review process, as needed. In this way, any actions conducted by WS would be responsive to ongoing changes and the associated cumulative impacts of actions conducted in Oklahoma in accordance with the NEPA.

RACCOON POPULATION INFORMATION AND EFFECTS ANALYSIS

The raccoon is a stocky mammal ranging from 61 to 91 cm (2 to 3 feet) long, weighing 4.5 to 13.5 kg (10 to 30 lbs). It is distinctly marked, with a prominent black mask over the eyes and a heavily furred, ringed tail. The animal is a grizzled salt-and-pepper gray and black above, although some individuals are strongly washed with yellow (Boggess 1994*b*).

Raccoons are omnivorous and they will eat carrion, garbage, birds, mammals, insects, crayfish, mussels, other invertebrates, and a wide variety of grains, various fruits, and other plant materials. They also eat most foods prepared for human or animal consumption (Sanderson 1987). They occasionally kill poultry (Boggess 1994*b*).

The raccoon is found throughout most of the United States, with the exception of the higher elevations of mountainous regions and some areas of the arid southwest (Boggess 1994*b*, Gehrt 2003). Raccoons are more common in the wooded eastern portions of the United States than in the more arid western plains (Boggess 1994*b*), and are frequently found in cities or suburbs, as well as rural areas (Gehrt 2003). Movements and home ranges of raccoons vary according to sex, age, habitat, food sources, season, and other factors. In general, males have larger home ranges than females. Home ranges of raccoons likely range from 50 to 300 hectares (124 to 742 acres) (Gehrt 2003).

Absolute raccoon population densities are difficult or impossible to determine because of the difficulty in knowing what percentage of the population someone has already counted or estimated. In addition, it can be difficult to determine how large an area the raccoons are using (Sanderson 1987). Due to their adaptability, raccoon densities reach higher levels in urban areas than that of rural areas. People have inferred relative raccoon population densities that they based on removal of animals per unit area. For example, Twichell and Dill (1949) reported removing 100 raccoons from tree dens in a 41-hectare (101 acres) waterfowl refuge area, while Yeager and Rennels (1943) studied raccoons on 881 hectares (2,177 acres) in Illinois and reported trapping 35 to 40 raccoons in 1938-1939, 170 in 1939-1940, and 60 in 1940-1941. Slate (1980) estimated one raccoon per 7.8 hectares (19.3 acres) in predominantly agricultural land on the inner coastal plain of New Jersey. Kennedy et al. (1991) estimated 13 raccoons per 100 ha (1 raccoon per 19 acres) of lowland forest in Tennessee. Around abundant food sources, Kern (2002) found raccoon densities could reach 100 raccoons per square mile (1 raccoon per 6.4 acres). Riley et al. (1998) summarized rural raccoon densities based on published literature that ranged from two to 650 per square mile in rural habitats, with an average of 10 to 80 raccoons per square mile.

In Oklahoma, raccoons cause damage to gardens, residential and non-residential buildings, fish, domestic fowl, livestock feed, poultry, and pets, as well as general property damage. Results of their feeding may be the total loss of ripened sweet corn in a garden. Damage to buildings generally occurs when they seek to gain entry or begin denning in those structures. Raccoons may den in uncapped chimneys, or may tear off shingles or fascia boards to gain access to attics or wall spaces. They may also damage or destroy sod by rolling it up in search of earthworms and other invertebrates (Boggess 1994*b*).

Many people who request assistance are also concerned about health and safety issues associated with raccoons. Those risks could include disease transmission from raccoons to people, pets, or livestock. Disease threats could include, but would not be limited to, canine distemper, rabies, and the roundworm *Baylisascaris procyonis*, the eggs of which survive for extremely long periods in raccoon feces and soil. Ingestion of *B. procyonis* eggs can result in serious or fatal infections in other animals, as well as people (Davidson 2006; see Table 1.3).

Raccoons can occur throughout the State of Oklahoma, and are common in a variety of habitats, including rural, suburban, and urban areas. Raccoons are closely associated with aquatic habitats, such as coastal marshes, swamps, rivers, lakes, and streams, as well as areas with mature hardwood trees (Gehrt 2003). However, the statewide population of raccoons is currently unknown. Therefore, the analysis will use the best available information to estimate a statewide population. Given the habitat preferences of raccoons, the most likely land cover types that would support raccoons are deciduous forest, mixed forest, shrub/scrub, and woody wetlands, which are primarily associated with the eastern portion of the State. The land area of Oklahoma is approximately 68,600 square miles; therefore, the eastern half of the State consists of approximately 34,300 square miles. If raccoons only occupied 50% of the eastern portion of the State (17,200 square miles), under a worst-case scenario, and using the average density reported by Riley et al. (1998) of 10 to 80 raccoons per square mile, the statewide population could range from 171,500 to 1.4 million raccoons. This would be a worst-case scenario since raccoon populations are likely to inhabit a much larger portion of the State. Similar to estimates derived for the other mammal species addressed in this EA, estimating that raccoons inhabit only 50% of certain land classifications in the State is intended to determine a minimum population estimate to compare the potential effects of WS' proposed removal of raccoons and to determine the magnitude of WS' proposed removal. Surveys conducted have shown that raccoon populations in Oklahoma are stable to slightly increasing (J. Davis, ODWC pers. comm. 2016).

Raccoons are a game and furbearing animal in Oklahoma with a regulated hunting and trapping season (ODWC 2016*b*). The ODWC currently allows a licensed hunter or trapper to harvest up to 10 raccoons per day with a season limit of 40 raccoons. In 2016, people sold 609 raccoon pelts at auctions in the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of raccoon pelts sold at auctions in the State occurred in 2012, when people sold 11,292 pelts (ODWC 2016*c*). As discussed previously, the actual number of raccoons harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. As with other furbearing species, other entities can lethally remove raccoons to alleviate damage or threats of damage. However, the number of raccoons removed by other entities to stop or alleviate damage is unknown.

From FY 2009 through FY 2016, the WS program in Oklahoma conducted 318 technical assistance projects involving raccoons. Request for assistance are typically associated with human health concerns, disease threats, property damage, and predation on poultry. From FY 2009 through FY 2016, WS lethally removed 1,278 raccoons in Oklahoma, which is an annual average removal of 160 raccoons. Between FY 2009 and FY 2016, WS intentionally live-captured 39 raccoons and released/relocated those raccoons. In addition, the WS program captured 140 raccoons unintentionally during other damage management activities between FY 2009 and FY 2016, with eight of those raccoons being released by WS.

Based on previous requests for assistance received by WS and in anticipation of additional efforts to manage raccoon damage, WS could lethally remove up to 500 raccoons annually under Alternative 1, including those raccoons that WS could lethally remove unintentionally during damage management activities targeting other animals. Using the population estimate ranging from 171,500 to 1.4 million raccoons, the removal of 500 raccoons under Alternative 1 would represent 0.04% to 0.3% of the estimated population. As stated previously, the actual statewide population likely exceeds 171,500 raccoons given the parameters used to estimate the population. Between 2012 and 2016, the highest number of raccoon pelts sold at auctions in the State was 11,292 pelts (ODWC 2016*c*). If the number of raccoon pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, if WS' annual removal reached 500 raccoons, would represent 6.9% of a statewide population estimated at 171,500 raccoons. Since the statewide population is likely higher than 171,500 raccoons for those reasons discussed previously, cumulative removal is likely a much smaller percentage of the actual statewide population.

Raccoon populations can remain relatively abundant if annual harvest levels are below 49% (Sanderson 1987). Therefore, if the statewide population of raccoons were 171,500 raccoons, the cumulative removal by all entities would have to reach 84,035 raccoons to cause the statewide population to begin to decline. If the statewide population of raccoons were 1.4 million raccoons, the cumulative removal of a raccoons would have to reach over 686,000 raccoons to cause the statewide population to decline. In addition, the statewide population is likely much higher than estimated in this analysis. Although the actual statewide population of raccoons is unknown, the cumulative removal of raccoons would be of low magnitude when compared to the actual statewide population. Therefore, the activities of WS to alleviate raccoon damage or threats of damage would not limit the ability of people to harvest raccoons in the State. Although the number of raccoons that people harvest in the State is unknown, along with the number of raccoons that people lethally remove to alleviate damage, the cumulative removal of raccoons is not likely to reach a magnitude where population declines would occur.

RED FOX POPULATION INFORMATION AND EFFECTS ANALYSIS

The red fox is a typically proportioned member of the dog family. The bushy and unusually long tail, pointed ears, slender muzzle, and slanted eyes coupled with its small dog size and typical reddish coloration, make the red fox instantly recognizable to most people. This species is also the most common and well-known species in the genus *Vulpes*, which includes about 10 other species worldwide (Cypher 2003). Typically, black-tipped ears, black cheek patches, white throat parts, a lighter underside, and black "*leg stockings*" occur on most red fox. The white tip of the tail (which is much more prominent in North American fox than elsewhere) can be used to distinguish brownish fox pups from similarly colored coyote pups, which lack a white tail tip (Voigt 1987, Cypher 2003).

In North America, the red fox weighs from 3.5 to 7 kilograms (7.7 to 15.4 lbs), with males averaging about one kilogram (2.2 lbs) heavier than females. Generally, adult fox measure 100 to 110 centimeters (39 to 43 inches) from the tip of the nose to the tip of the tail. Juveniles in their first autumn are similar in size to adults (Voigt 1987). Red fox occur over most of North America, north and east from southern California, Arizona, and central Texas. They occur throughout most of the United States with the exception of a few isolated areas. Prehistoric fossil records suggest that the red fox may not have inhabited much of the United States, but they were plentiful in many parts of Canada. However, climatic factors, interbreeding with the introduced European red fox, extirpation of the wolves, and clearing of land for agriculture has possibly contributed to the present-day expansion and range of this species in North America (Voigt 1987, Cypher 2003).

Red fox are adaptable to most habitats within their range, but usually prefer open country with moderate cover. Some of the highest fox densities reported are in the north-central United States and occur where woodlands are interspersed with farmlands. Red fox have also demonstrated their adaptability by establishing breeding populations in many urban areas of the United States, Canada, and Europe (Phillips and Schmidt 1994). In many areas, competition with other canids and the availability of suitable year-round food resources limit fox survival. Habitat determines the availability of year-round food resources and the presence or absence of other canids. Because those two factors strongly influence red fox survival, habitat limits fox numbers but seldom limits distribution (Voigt 1987).

Red fox mate from December to April and produce litters of one to 12 kits after a gestation period of 51 to 54 days. They rear young in a maternity den, commonly an enlarged woodchuck or badger den, usually in sparse ground cover on a slight rise, with a good view of all approaches (Cypher 2003). Juvenile fox are able to breed before reaching a year old, but in areas of high red fox densities, most yearlings do not produce pups their first year (Harris 1979, Voigt and MacDonald 1984, Voigt 1987). Gier (1968) reported average litter sizes of 4.8 to 5.1 in years with low rodent numbers, but litters of 5.8 to 6.2 during years with high rodent numbers. Offspring disperse from the denning area during the fall and establish breeding areas in vacant territories, sometimes dispersing considerable distances. Red fox are generally solitary animals as adults, except when mating (Phillips and Schmidt 1994). Rabies and distemper are associated with this species (Cypher 2003).

The red fox is a skilled nonspecific predator, foraging on a variety of prey. Red fox are also an efficient scavenger, and in parts of the world, garbage and carrion are extremely important to its diet (Voigt 1987). They are opportunists, feeding mostly on rabbits, mice, bird eggs, insects, and native fruit. They usually kill animals smaller than a rabbit, although fawns, pigs, kids, lambs, and poultry are sometimes killed (Phillips and Schmidt 1994).

Densities of red fox can be difficult to determine because of the animals secretive and elusive nature. Estimates are prone to error even in open areas with good visibility. Methods used to estimate numbers have included aerial surveys, questionnaires to rural residents and mail carriers, scent post surveys, intensive ground searches, and indices derived from hunting and trapping harvest (Voigt 1987, Cypher 2003). In Great Britain, where food is abundant in many urban areas, densities as high as 30 fox per square kilometer (78 per mi^2) have been reported (Harris 1977, MacDonald and Newdick 1982, Harris and Rayner 1986), while in southern Ontario, densities of about 1 fox per square kilometer (2.6 per mi^2) occur during spring. This includes both pups and adults. In small areas of the best habitat, three times as many fox have been observed (Voigt 1987). However, those densities rarely occur extensively because of the dispersion of unsuitable habitat, high mortality, or from competition with coyotes (Voigt and Earle 1983). Cyclical changes in fox numbers occur routinely and complicate density estimates as well as management. Those cycles can occur because of changes in prey availability, or disease outbreaks, especially rabies, among red fox. For fox populations to remain relatively stable, mortality and reproduction must balance approximately.

Home ranges for red fox in the eastern United States are usually from 500 to 2,000 hectares (1,235 to 4,940 acres) in rural settings, such as farmland (Voigt and Tinline 1980), but such sizes may not apply among fox populations in urban settings.

In Oklahoma, the red fox occurs primarily in the eastern portion of the State and their populations are likely increasing in many parts of eastern Oklahoma (ODWC 2011*d*). Ideal habitat for the red fox in Oklahoma is an area of dense timber, located within or near a pasture or other farmland (ODWC 2011*d*). Like other furbearing species in the State, the statewide population is currently unknown. In addition, density data for red fox in Oklahoma is not currently available. Surveys indicate that the red fox population in Oklahoma is stable to slightly increasing (J. Davis, ODWC pers. comm. 2016). The land area of Oklahoma is approximately 68,600 square miles; therefore, the eastern half of the State consists of approximately 34,300 square miles. If red fox only occupied habitat in 50% of the eastern portion of the State (17,200 square miles) and the density of red fox were 2.6 red fox per square mile of habitat, the statewide population would be approximately 43,700 red fox.

Similar to gray fox, hunters and trappers can harvest red fox during annual hunting and trapping seasons in the State. During the length of the hunting and trapper seasons, licensed hunters and trappers can harvest up to one red fox per day with a season limit of two red fox. In 2016, people sold one red fox pelt at auctions in the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of red fox pelts sold at auctions in the State occurred in 2012, when people sold 60 pelts (ODWC 2016*c*). As discussed previously, the actual number of red fox harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. As with other furbearing species, other entities can lethally remove red fox to alleviate damage or threats of damage. However, the number of red fox removed by other entities to stop or alleviate damage is unknown.

Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 318 technical assistance projects involving red fox. Most requests for assistance associated with red fox that WS receives involve disease threats, aircraft strike risks, and predation to poultry. During direct operational assistance projects, WS lethally removed 40 red fox intentionally from FY 2009 through FY 2016, which is an average lethal removal of five red fox per year. In addition, four red fox were lethally removed unintentionally during other damage management activities. WS also intentionally live-captured and released/dispersed eight red fox during activities conducted from FY 2009 through FY 2016.

Based on previous requests received by WS to reduce damage and in anticipation of additional efforts, WS could lethally remove up to 20 red fox annually if the WS program implemented this alternative, including fox that WS could lethally remove unintentionally during other damage management activities. Using a population estimate of 43,700 red fox, the lethal removal of up to 20 red fox annually by WS would represent under 0.1% of the estimated population. As discussed previously, between 2012 and 2016, the highest number of red fox pelts sold at auctions in the State was 60 pelts (ODWC 2016*c*). If the number of red fox pelts sold at auctions in the State during 2012 were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, if WS' annual removal reached 20 red fox, would represent 0.2% of a population estimated at 43,700 red fox. Although the number of red fox that people harvest in the State is unknown, the cumulative harvest of red fox is not likely to reach a magnitude where population declines would occur.

Activities conducted under this alternative would target individual red fox or local populations of fox at sites where they were causing damage to agriculture, human health or safety, natural resources, or property. Those activities to reduce specific damage could temporarily reduce some local populations. The annual removal of red fox by WS would be of low magnitude compared to the actual population in the State. Therefore, the activities of WS to alleviate red fox damage or threats of damage would not limit the ability of people to harvest red fox in the State.

RIVER OTTER POPULATION INFORMATION AND EFFECTS ANALYSIS

Historically, river otters inhabited aquatic ecosystems throughout much of North America, excluding the frozen Arctic and arid Southwest (Melquist et al. 2003). Information on historic numbers and distribution is limited. As its broad geographic distribution suggests, the river otter is able to adapt to diverse aquatic habitats. Otter occur in both marine and freshwater environments, ranging from coastal to high mountainous habitat. Riparian vegetation adjacent to lakes, streams, and other wetland areas is a key component of otter habitat.

Human encroachment, habitat destruction, and overharvest have eliminated river otters from marginal portions of their range. However, their present distribution spans the North American continent from east to west and extends from southern Florida to northern Alaska (Melquist and Dronkert 1987, Melquist et al. 2003). In southeast Alaska, Woolington (1984) found river otter densities in waterways were one otter per 0.7 miles. Melquist and Dronkert (1987) summarized studies estimating river otter densities, which showed that densities were about 1 per 175 to 262 acres in Texas coastal marshes, and ranged from 1 per 1.8 miles to 1 per 3.6 miles of waterway (stream or river), which is an average of 1 otter per 2.4 miles of waterway. Melquist and Hornocker (1983) found a population density range of 1 otter per 1.8 to 3.6 miles of waterway (primarily streams) in west central Idaho, with an average of 1 otter per 2.4 miles. Erickson et al. (1984) found one otter per 5.0 miles of linear waterways in Missouri and one otter per 1.5 square miles in wetland habitat. More recently, Mowry et al. (2011) found an average otter density of one otter per 2.6 miles along streams in Missouri using latrine surveys.

Although once common in the rivers, streams, and other permanent water bodies of the State, the loss of habitat and the unregulated harvest of otter caused their population in the State to decline to a point that, by the 1950s, river otter were rare or extirpated from the State (Davis 2014). After habitat restoration efforts and the construction of reservoirs, the river otter population in the State began to increase as otters from surrounding states expanded into Oklahoma. Bolstered by the release of otters by the ODWC, river otters continued to expand and now regularly occur east of Interstate 35. The incidental capture of river otter have occurred as far west as Canadian, Comanche and Caddo Counties (Davis 2014). In 2007, the ODWC established the first river otter season in the State. Today, people can harvest river otter during the open season, which allows people with the appropriate license to harvest up to four otters during the season (Davis 2014). Surveys conducted have shown that the river otter population is increasing (J. Davis, ODWC pers. comm. 2016).

The population of river otter in the State is currently unknown; however, river otter currently occur in permanent water sources, such as wetland habitats and streams, rivers, and lakes, east of Interstate 35 in the State (ODWC 2011*e*, Davis 2014). No population estimates or density estimates were available for otter in Oklahoma. Therefore, this analysis will use the best available information to estimate a statewide population. There are approximately 167,600 miles of perennial and intermittent streams and rivers and 55,646 miles of shoreline along lakes and ponds in Oklahoma (Oklahoma Water Resources Board 2016), with 950,000 acres of wetlands (United States Geological Survey 1996, Association of State Wetland Managers 2013). If river otter occur east of Interstate 35 in the State, river otters currently occupy nearly half of the State, since the interstate divides the State nearly in half. If only 25% of the 167,600 miles of streams in the State supported river otter and if the population density of river otter were only one otter per 2.5 to 5.0 miles of waterway, the minimum river otter population could range from 8,400 to 16,800 otter in Oklahoma. This would be a worst-case scenario since the otter population may actually inhabit other aquatic habitats in Oklahoma. Many lakes and private ponds across Oklahoma are currently populated with river otters. However, these numbers are unknown and were not considered in this population estimate.

River otters are furbearing animals in Oklahoma with a regulated trapping season. As stated previously, people with the appropriate license can harvest up to four otters during the trapping season (ODWC 2016*b*). In 2016, people sold 40 river otter pelts at fur auctions in the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of river otter pelts sold at auctions in the State occurred in 2012, when people sold 208 pelts (ODWC 2016*c*). As discussed previously, the actual number of river otter harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. For example, people who harvest river otter must report their harvest to the ODWC and people must place a tag from the ODWC on the pelt. During the 2015-2016 trapping season, the ODWC tagged 330 river otters (J. Davis, ODWC pers. comm. 2016).

Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 76 technical assistance projects involving river otters. Most requests for assistance involved river otter feeding in private ponds stocked with fish and feeding at commercial fish operations. During all direct operational assistance projects conducted from FY 2009 through FY 2016, WS removed 429 river otters in Oklahoma, which is average removal of 54 river otters per year. Of those otters removed by WS from FY 2009 through FY 2016, WS removed 274 otter as unintentional non-target animals during aquatic rodent damage management activities. The analysis discusses the unintentional removal of otter during activities associated with aquatic rodent damage management to evaluate the cumulative removal of otter. Based on previous requests for assistance and anticipating additional efforts to address damage, WS could lethally remove up to 100 river otters annually in Oklahoma, including otters that WS could lethally remove unintentionally during other damage management activities. WS anticipates receiving requests primarily from aquaculture producers experiencing unacceptable predation of fish stock by river otters.

Removal of up to 100 river otter by WS would represent 1.2% of the statewide population of 8,400 river otter in Oklahoma and 0.6% of a population estimated at 16,800 river otters. WS could also lethally remove river otter unintentionally during other damage management activities; however, WS does not anticipate the cumulative lethal removal of otter to exceed 100 otter annually. As discussed previously, between 2012 and 2016, the highest number of river otter pelts sold at auctions in the State was 59 pelts (ODWC 2016*c*). However, trappers harvested 330 river otters during the 2015-2016 season based on the number of otters that ODWC tagged. If the number of river otter harvested during the 2015-2016 season were representative of harvest that could occur in the future, the cumulative removal by trappers and WS, if WS' annual removal reached 100 otters, would represent 5.1% of a statewide population estimated at 8,400 otter and 2.6% of a statewide population estimated at 16,800 otter.

Activities conducted under this alternative would target individual river otter or local populations of river otter at sites where they were causing damage. Those activities to reduce specific damage could temporarily reduce some local populations. Although the actual statewide population of river otters is unknown, the cumulative removal of otter would be of low magnitude when compared to the actual statewide population based on the worst-case scenario analyzed. Therefore, the activities of WS to alleviate river otter damage or threats of damage would not limit the ability of people to harvest otters in the State.

STRIPED SKUNK POPULATION INFORMATION AND EFFECTS ANALYSIS

Although easily recognized by their black and white fur, striped skunks are likely more recognizable by the odiferous smell of their musk. They are common throughout the United States and Canada (Rosatte 1987, Rosatte and Larivière 2003). Striped skunks are primarily nocturnal and do not have a true hibernation period; however, during extremely cold weather skunks may become temporarily dormant.

The striped skunk is an omnivore, feeding heavily on insects, such as grasshoppers, crickets, beetles, bees, and wasps (Rosatte and Larivière 2003). The diet of the striped skunk also includes small mammals and the eggs of ground-nesting birds and amphibians. Striped skunks are typically not aggressive and they will attempt to flee when approached by people (Rosatte 1987). However, when provoked, skunks will give a warning and assume a defensive posture prior to discharging their foul-smelling musk. This musk is comprised of sulfur-alcohol compounds known as butylmercaptan (Rosatte and Larivière 2003).

Adult skunks begin breeding in mid-February through mid-April. Yearling females (born in the preceding year) mate in late March. Gestation usually lasts about 59 to 77 days. Litters commonly consist of five to seven young with two litters per year possible (Rosatte and Lariviere 2003). The home range of striped skunks is usually not consistent. Home ranges appear to be reliant upon life history requirements, such as winter denning, feeding activities, dispersal, and parturition (Rosatte 1987). According to Chamberlain and Leopold (2001), very little information regarding striped skunk densities in the southeast exists except densities based on harvest numbers and trapper/hunter observations. During the breeding season, males may travel larger areas in search of females. Skunk densities vary widely according to season, food sources, and geographic area. Densities may range from one skunk per 77 acres to one skunk per 10 acres (Rosatte 1987).

Striped skunks occur statewide in Oklahoma and are generally common around open areas, forest edges, and in urban areas. Population estimates and density estimates for striped skunks in Oklahoma are currently not available. Striped skunks can occur in a variety of habitats across the State. Striped skunks are common across most of 69,960 square miles (or 44,774,400 acres) of Oklahoma. Based on the lowest density of 77 acres per skunk, the population estimate would be approximately 581,500 striped skunks in Oklahoma. However, if only 50% of the acreage in Oklahoma was suitable habitat for striped skunks, and if striped skunks were only present in 50% of that suitable habitat, then the most conservatively estimated population would be 145,400 skunks. Similar to other furbearing species, skunks can occur throughout the State and analysis evaluates a population under a worst-case scenario to evaluate the magnitude of removal proposed under this alternative. The statewide population of skunks is likely higher than 145,400 striped skunks. Surveys indicate that the striped skunk population is increasing (J. Davis, ODWC pers. comm. 2016).

Skunks are a furbearing animal in Oklahoma with year around open seasons with no limit on the number of skunks that people can harvest daily and no limit on the number of skunks that people can possess throughout the trapping season. During 2016, people sold 79 striped skunk pelts at fur auctions in the State. Between 2012 and 2016, the highest number of skunk pelts sold at auctions in the State occurred in 2013, when people sold 218 pelts (ODWC 2016*c*). As discussed previously, the actual number of skunks harvested in the State is unknown since people do not necessary sell all their pelts at fur auctions the same year they harvest an animal. The number of skunks that people remove annually to alleviate damage or disease threats is unknown.

WS conducted 551 technical assistance projects associated with skunks in the State between FY 2009 and FY 2016. WS addressed most requests for technical assistance by providing information on methods the requester could employ to alleviate damage or threats without any direct involvement by WS. WS has received requests regarding damage or threats of damage to property, residential buildings, non-residential buildings, pets, turf, flowers, and human safety. Damage and threats occurred primarily from the burrowing/digging behavior of skunks, the odor associated with skunks spraying, and rabies threats. Most requests for assistance received were associated with threats to human safety, primarily risks of disease transmission.

From FY 2009 through FY 2016, WS lethally removed 1,068 striped skunks during all damage management activities in the State, which is an average annual removal of 134 skunks. Of the striped skunks lethally removed by WS in Oklahoma, WS intentionally removed 938 skunks, and 130 were the result of unintentional removal during other activities conducted by WS. Based on previous requests for assistance received by WS and in anticipation of additional efforts to manage striped skunk damage in Oklahoma, up to 300 skunks could be lethally removed by WS annually under this alternative. Using the lowest population estimate of 145,400 skunks, the removal of 300 skunks would represent 0.2% of the estimated statewide population. WS could also lethally remove striped skunks unintentionally during other damage management activities; however, WS does not anticipate the cumulative lethal removal of skunks to exceed 300 skunks annually. If WS' removal of skunks reached 300 skunks annually, and if the highest number of skunks sold at fur auctions (218 skunks) was representative of future harvest, the cumulative lethal removal of skunks would represent 0.4% of a statewide population estimated at 145,400 skunks. However, the statewide population is likely to be higher than 145,371 skunks; therefore, cumulative removal is likely to represent a smaller percentage of the actual population.

The ODWC allows people to harvest an unlimited number of skunks during the annual harvest season, which provides an indication that skunk densities in the State are sufficient to maintain a sustained harvest level and adverse effects from harvest and damage management purposes are not likely to cause overharvest of the species leading to population declines. The annual removal of skunks by WS would be of low magnitude compared to the actual statewide population. Therefore, the activities of WS to alleviate skunk damage or threats of damage would not limit the ability of people to harvest skunks in the State. Surveys indicate that the striped skunk population is increasing (J. Davis, ODWC pers. comm. 2016).

VIRGINIA OPOSSUM POPULATION INFORMATION AND EFFECTS ANALYSIS

Opossums are the only marsupials (*i.e*., possess a pouch in which young are reared) found north of Mexico (Seidensticker et al. 1987, Gardner and Sunquist 2003). They occur over most of the eastern and central United States with scattered occurrences across parts of the western United States, primarily around urbanization areas (Gardner and Sunquist 2003). They also occur in the western portions of California, Oregon, and Washington (Gardner and Sunquist 2003). Adults range in size from less than 1 kilogram (2.2 lbs) to about 6 kilogram (13 lbs), depending on sex and time of year. They have a broad range of pelage colors, but are usually a "*gray*" or "*black*" phase. Their fur is grizzled white above; long white hairs cover black tipped fur below. They climb well and feed on a variety of foods, including carrion, which forms much of its diet. In addition, opossum eat insects, frogs, birds, snakes, small mammals, earthworms, corn, berries, and other fruits, such as persimmons and apples (Gardner and Sunquist 2003). They use a home range of four to 20 hectares (10 to 50 acres), foraging throughout this area frequently (Jackson 1994), but concentrating on a few sites where fruits abound, when they are in season (Seidensticker et al. 1987, Gardner and Sunquist 2003).

The reproductive season of the Virginia opossum typically occurs from December to February, depending on latitude (Gardner 1982, Gardner and Sunquist 2003). Gestation is short (average of 12.8 days) with one to 17 young born in an embryonic state that climb up the mothers belly to the marsupium (pouch), attach to teats, and begin to suckle (Gardner 1982, Gardner and Sunquist 2003). Those young remain in the pouch for about two months. After two months, the young begin to explore and may travel on their mother's back with their tails grasping hers (Whitaker and Hamilton 1998). Opossum live for only one to two years, with as few as 8% of a population of those animals surviving into the second year in a study in Virginia conducted by Seidensticker et al. (1987). In that five-year study, Seidensticker et al. (1987) noted there was a wide variation in opossum numbers, in what they considered excellent habitat for the species. Those variations occurred seasonally and in different years. However, the mean density during the study was 10.1 opossum per square mile with a range of 1.3 opossum per square mile to 20.2 opossum per square mile (Seidensticker et al. 1987). This was comparable to other opossum population densities in similar habitats in Virginia. Verts (1963) found a density estimate of 10.1 opossum per square mile in farmland areas of Illinois, while Wiseman and Hendrickson (1950) found a density of 6.0 opossum per square mile in mixed pasture and woodlands in Iowa. However, VanDruff (1971) found opossum densities in waterfowl nesting habitat as high as 259 opossum per square mile.

Population estimates and density information for opossum in the State are not available. However, population trends show a stable to slightly increasing population (J. Davis, ODWC pers. comm. 2016). Therefore, the analysis will derive a population estimate based on the best available information for opossum to provide an indication of the magnitude of removal proposed by WS to alleviate damage and threats of damage. Opossum are common throughout Oklahoma in appropriate habitat. Opossums are primarily associated with deciduous woodlands near streams, marshlands, forests, grasslands, agricultural habitats, agricultural edges (Seidensticker et al. 1987). Given that opossum prefer grasslands, agricultural areas, and forestlands, the land area most associated with those areas occurs in the eastern half of the State. This area would be approximately 34,980 square miles. If opossum were only found on 50% of those land classifications in the State (17,490 square miles) and using a mean density of 10.1 opossum per square mile found by Seidensticker et al. (1987) in Virginia, the population would be estimated at nearly 176,600 opossum. Using the range of opossum densities found by Seidensticker et al. (1987) of 1.3 opossum per square mile to 20.2 opossum per square mile and only 50% of the land area in the eastern half of the State being occupied by opossum, the statewide population would range from a low of 22,700 opossum to a high of nearly 353,300 opossum. Opossum occupying only 50% of those land classifications in the State is unlikely since opossum can occur statewide. However, the analysis used opossum occupying only 50% of the land area in the eastern half of the State to provide a minimum population estimate to determine the magnitude of the proposed removal by WS to alleviate or prevent damage.

Opossum are a furbearing animal and a game animal in the State and can be harvested during annual hunting and trapping seasons (ODWC 2016*b*). During the development of the EA, people with the appropriate license could harvest opossum during hunting and trapping seasons with no limit on the number that people could harvest during those seasons. In 2016, people sold 470 opossum pelts at fur auctions in the State (ODWC 2016*c*). Between 2012 and 2016, the highest number of opossum pelts sold at auctions in the State occurred in 2012, when people sold 1,353 pelts (ODWC 2016*c*). In addition, people can lethally remove opossum themselves to alleviate damage; however, the number of opossum lethally removed by other entities in the State to alleviate damage is also unknown.

Between FY 2009 and FY 2016, the WS program in Oklahoma conducted 57 technical assistance projects involving opossum. Agriculture damage, health and human safety, disease, and property damage were the primary concerns of requesters when calling for assistance with opossums. As part of all damage management activities conducted by WS in the State, WS lethally removed 317 opossum from FY 2009 through FY 2016, which is an average annual removal of 40 opossum. Of those 317 opossums lethally removed by WS from FY 2009 through FY 2016, WS removed 84 opossum as unintentional non-target animals during other damage management activities. In addition, WS live-captured and released/dispersed two opossum from FY 2009 through FY 2016 during damage management activities.

Based on previous requests for assistance received by WS and in anticipation of additional efforts, WS could lethally remove up to 100 opossum annually in the State under this alternative. Based on a statewide population of 22,700 opossum, the lethal removal of 100 opossum annually by WS under this alternative would represent 0.4% of the estimated population. WS could also lethally remove opossum unintentionally during other damage management activities conducted by WS; however, WS does not anticipate the cumulative lethal removal of opossum to exceed 100 opossum annually.

The highest number of opossum pelts sold at auctions in the State between 2012 and 2016 was 1,353 pelts. If highest number of pelts sold at auctions in the State were representative of harvest that could occur in the future, the cumulative removal by hunters, trappers, and WS, (if WS' removal reached the 100 opossum), would represent 0.4% of a population estimated at 353,300 opossum and 6.4% of a statewide population estimated at 22,700 opossum.

Although the total number of opossum lethally removed in the State by other entities to alleviate damage is unknown, the cumulative removal of opossum, including the proposed removal of 100 opossum annually by WS, would be of a low magnitude when compared to the actual statewide population. The unlimited harvest allowed by the ODWC during the harvest seasons provides an indication that population densities of opossum in the State are sufficient that overharvest is not likely to occur, including lethal removal to alleviate or prevent damage. In addition, the live-capture and subsequent release of opossum would not likely result in adverse effects to the statewide population since those animals would be released unharmed. Based on the low magnitude of removal that could occur by WS to the statewide population, WS' activities would not limit the ability to harvest opossum in the State.

ADDITIONAL TARGET SPECIES

In addition to badgers, bobcats, coyotes, feral/free-ranging cats, feral/free-ranging dogs, gray fox, mink, raccoons, red fox, river otters, striped skunks, and Virginia opossum, WS has addressed a limited number of or WS anticipates addressing a limited number of black bears, hog-nosed skunks, long-tailed weasels, ringtails, spotted skunks, and swift fox under Alternative 1. Requests for assistance associated with those species would often occur infrequently or would involve only a few individuals. As shown in Table 1.1, WS addresses most requests for assistance associated with those species by providing technical assistance. Between FY 2009 and FY 2016, WS has conducted 14 projects involving black bears, two projects involving hog-nosed skunks, and two projects involving long-tailed weasels. Under Alternative 1, WS could receive requests for assistance to use lethal methods to remove those species when non-lethal methods were ineffective or were determined to be inappropriate using the WS Decision model.

No lethal removal of black bears, hog-nosed skunks, least weasels, ringtails, spotted skunks, or swift fox has occurred by WS between FY 2009 and FY 2016. WS does not expect the annual removal of black bears, hog-nosed skunks, long-tailed weasels, mountain lions, ringtails, spotted skunks, and swift fox by the program to occur at any level that would adversely affect populations of those species. Removal would be limited to those individuals deemed causing damage or posing a threat. WS would continue to provide the ODWC with activity reports, which would allow the ODWC to consider the cumulative removal of target species by WS.

People can harvest black bears and long-tailed weasels in the State during annual hunting and/or trapping seasons. During the open harvest season for long-tailed weasels, the ODWC places no limits on the number that people can harvest during the open seasons. The number of weasels that people harvest in the State annually is unknown. During 2015, people harvested 52 black bears in the State (Ford 2016). The WS program in Oklahoma has occasionally received requests for assistance associated with black bears, but WS has provided only technical assistance and referred people to the ODWC for further action. WS and the ODWC have a MOU, which gives ODWC the lead role in responding to black bear request for assistance from the public. In the MOU, the ODWC would be responsible for any trapping and relocating activities in Oklahoma; however, WS could assist the ODWC in those activities, if requested. There is no open harvest season in the State for hog-nosed skunks, ringtails, spotted skunks, and swift fox.

The historic range of the swift fox extended from eastern New Mexico and western Texas north through portions of Oklahoma, Colorado, Kansas, Nebraska, Wyoming, South Dakota, Montana, North Dakota, and into portions of the Canadian provinces of Alberta, Saskatchewan, and Manitoba (Sovada et al. 2009). Swift fox are a species of special concern in Oklahoma (ODWC 2011*f*). In Oklahoma, swift fox occur in northwestern Oklahoma in the panhandle portion of the State. Suitable habitat for the swift fox present in the State appears to be short grass prairie rangeland or locations where rangeland is intermixed with non-irrigated crop fields (ODWC 2011*f*). The ODWC currently monitors the swift fox population in Oklahoma through standardized surveys. Although predation of livestock rarely occurs from swift fox, if WS confirmed predation by swift fox, WS could receive a request to target a swift fox or a pair of swift during direct operation assistance projects. However, any removal would occur after consultation with the ODWC.

WS could lethally remove swift fox unintentionally during activities that target other animals. However, no lethal removal of swift fox has occurred by WS. WS would implement those SOPS discussed in Section 3.4 to reduce the risk of capturing a swift fox unemotionally. WS' activities could benefit swift fox populations in the State. Coyote predation on swift fox is a concern. Coyote predation on swift fox is a major cause of mortality in some parts of its range (Sovada et al. 1998, Schautster et al. 2002, Cypher 2003). A localized reduction in coyote abundance from swift fox areas would potentially benefit the swift fox population (Allardyce and Sovada 2003).

The WS program in Oklahoma and the ODAFF expects activities associated with black bears, hog-nosed skunks, long-tailed weasels, ringtails, spotted skunks, and swift fox under Alternative 1 to remain similar to previous activities. WS and the ODAFF are likely to continue addressing requests for assistance associated with those species by providing technical assistance. The WS program and the ODAFF do not anticipate the lethal removal of those species to increase substantially. Lethal removal is likely to occur infrequently and involve the removal of one or two individuals of a species to alleviate damage when lethal removal does occur. In addition, the ODWC would continue to monitor activities conducted by WS to ensure activities occurred within management objectives established by the ODWC. Based on the limited removal proposed by WS and the oversight by the ODWC, WS' removal of those species annually would have no effect on the ability of those persons interested to harvest those species that people can harvest in the State. In addition, if WS implemented this alternative, the WS program in Oklahoma would monitor activities conducted to ensure program activities continue to occur within the impact parameters evaluated in the EA. Through the review of activities and through consultation with the ODWC, the WS program in Oklahoma can evaluate and adjust activities conducted. Accordingly, WS could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review process, as needed. In this way, any actions conducted by WS would be responsive to ongoing changes and the associated cumulative impacts of actions conducted in Oklahoma in accordance with the NEPA.

EFFECTS OF WILDLIFE DISEASE SURVEILLANCE AND MONITORING

The ability to efficiently conduct surveillance for and detect diseases is dependent upon rapid detection of the pathogen if it is introduced. Effective implementation of a surveillance system would facilitate planning and execution at regional and state levels, and coordination of surveillance data for risk assessment. It would also facilitate partnerships between public and private interests, including efforts by federal, state, and local governments as well as non-governmental organizations, universities, and other interest groups.

Under disease sampling strategies that could be implemented to detect or monitor diseases in the United States, WS' implementation of those sampling strategies would not adversely affect predator populations in the State. Sampling strategies that could be employed involve sampling live-captured predators that could be released on site after sampling occurs. The sampling (*e.g.*, drawing blood, tissue sample, fecal sample) and the subsequent release of live-captured predators would not result in adverse effects since those predators would be released unharmed on site. In addition, the sampling of predators that were sick, dying, or harvested by hunters would not result in the additive lethal removal of predators that would not have already occurred in the absence of disease sampling. Therefore, the sampling of predators for diseases would not adversely affect the populations of any of the predators addressed in this EA nor would sampling predators result in any lethal removal of predators that would not have already occurred in the absence of disease sampling (*e.g.*, hunter harvest). If WS lethally removed predators specifically for disease sampling or as part of a disease outbreak, the annual lethal removal would occur within the impact parameters evaluated previously. If annual removal of predators for disease sampling would occur outside the impact parameters evaluated in this EA, WS and the ODAFF would conduct additional evaluations pursuant to the NEPA related to those activities.

EFFECTS ON THE PUBLIC'S AESTHETIC ENJOYMENT OF PREDATORS

A concern expressed by some people is WS' activities would result in the loss of aesthetic benefits of animals to the public, resource owners, or neighboring residents. People generally regard animals as providing economic, recreational, and aesthetic benefits (Decker and Goff 1987), and the mere knowledge that animals exists is a positive benefit to many people. 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.

The human attraction to animals likely started when people began domesticating animals. The public today share a similar bond with animals and/or wildlife in general and in modern societies, a large percentage of households have indoor or outdoor pets. However, some people may consider individual wild animals as "*pets*" or exhibit affection toward those animals, especially people who enjoy viewing animals. Therefore, the public reaction can be variable and mixed to animal damage management because there are numerous philosophical, aesthetic, and personal attitudes, values, and opinions about the best ways to manage conflicts/problems between people and animals.

Animal populations provide a wide range of social and economic benefits (Decker and Goff 1987). Those include direct benefits related to consumptive and non-consumptive uses, indirect benefits derived from vicarious wildlife related experiences, and the personal enjoyment of knowing animals exists and contributes to the stability of natural ecosystems (Bishop 1987). Direct benefits are derived from a personal relationship with animals and may take the form of direct consumptive use (*e.g.,* using parts of or the entire animal) or non-consumptive use (*e.g.*, viewing the animal in nature or in a zoo, photographing) (Decker and Goff 1987).

Indirect benefits or indirect exercised values arise without the user being in direct contact with the animal and originate from experiences, such as looking at photographs and films of animals, reading about animals, or benefiting from activities or contributions of animals (*e.g*., their use in research) (Decker and Goff 1987). Indirect benefits come in two forms: bequest and pure existence (Decker and Goff 1987). Bequest is providing for future generations and pure existence is merely knowledge that the animals exist (Decker and Goff 1987).

Public attitudes toward animals vary considerably. Some people believe that WS should capture and translocate all animals to another area to alleviate damage or threats those animals pose. In some cases, people directly affected by animals strongly support removal. Individuals not directly affected by the harm or damage may be supportive, neutral, or totally opposed to any removal of animals from specific locations or sites. Some people totally opposed to animal damage management want WS to teach tolerance for damage and threats caused by animals, and that people should never kill animals. Some of the people who oppose removal of animals do so because of human-affectionate bonds with individual animals. Those human-affectionate bonds are similar to attitudes of a pet owner and result in aesthetic enjoyment.

In some cases, the presence of overabundant mammal species offends people, such as raccoons, coyotes, or feral species, such as cats or dogs. To such people, those species represent pests that are nuisances, which upset the natural order in ecosystems, and are carriers of diseases transmissible to people or other animals. In those situations, the presence of overabundant species can diminish their overall enjoyment of other animals by what they view as a destructive presence of such species. They are offended because they feel that those species proliferate in such numbers and appear to remain unbalanced.

In the wild, few animals in the United States have life spans approaching that of people. Mortality is high among wildlife populations and specific individuals among a species may experience death early in life. Mortality in wildlife populations is a natural occurrence and people who form affectionate bonds with animals experience loss of those animals over time in most instances. A number of professionals in the field of psychology have studied human behavior in response to attachment to pet animals (Gerwolls and Labott 1994, Marks et al. 1994, Zasloff 1996, Ross and Baron-Sorensen 1998, Archer 1999, Meyers 2000). Similar observations are probably applicable to close bonds that could exist between people and wild animals. As observed by researchers in human behavior, normal human responses to loss of loved ones proceed through phases of shock or emotional numbness, sense of loss, grief, acceptance of the loss or what cannot be changed, healing, and acceptance and rebuilding which leads to resumption of normal lives (Lefrancois 1999). Those people who lose companion animals, or animals for which they may have developed a bond and affection, can proceed through the same phases as with the loss of human companions (Gerwolls and Labott 1994, Boyce 1998, Meyers 2000). However, they usually establish a bond with other individual animals after such losses. Although they may lose the sense of enjoyment and meaning from the association with those animals that die or are no longer accessible, they usually find a similar meaningfulness by establishing an association with new individual animals or through other relational activities (Weisman 1991). Through this process of coping with the loss and establishing new affectionate bonds, people may avoid compounding emotional effects resulting from such losses (Lefrancois 1999).

WS only conducts activities on properties where the landowner or property manager signs a MOU, work plan, work initiation document, or a similar document allowing WS' personnel to conduct activities and personnel would only target those animals identified as causing damage or posing a threat of damage. In addition, other individuals of the same species would likely continue to be present in the affected area and people would tend to establish new bonds with those remaining animals. In addition, human behavior processes usually result in individuals ultimately returning to normalcy after experiencing the loss of association with a wild animal that an entity removed from a specific location.

Even in the absence of any involvement by WS, other entities could conduct activities to alleviate damage or threats of damage. Since other entities could remove predators causing damage or posing a threat of damage, the involvement of WS in removing those predators would not likely be additive to the number of predators that could be removed in the absence of involvement by WS. In addition, activities that could occur under the alternatives by WS would occur on a relatively limited portion of the total area in Oklahoma, and the portion of various predator species' populations removed would typically be low (see preceding discussion). In localized areas where WS removes predators, 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. Those target species addressed in this EA are relatively abundant, but people may not commonly observe those species because many of the species are secretive and nocturnal. As discussed previously, the effects on target predator populations from damage management activities would be relatively low if WS implemented Alternative 1, and opportunities to view, hear, or see evidence of predators would still be available over the majority of land area of the State.

EFFECTS ON RECREATIONAL ACTIVITIES

Public opinion about the best ways to reduce conflicts between people and animals is highly variable, making the implementation and conduct of damage management programs extremely complex. Some people express concerns that proposed activities could interfere with their enjoyment of recreational activities associated with animals. Recreational activities can include consumptive activities, such as hunting and fishing and non-consumptive activities, such as wildlife viewing and wildlife photography. The mere knowledge that wildlife exists is a positive benefit to many people (Decker and Goff 1987). Recreational activities can also be an important component of the economy in Oklahoma.

In 2011, the USFWS and the United States Department of Commerce (2011) found over 1.7 million people participated in wildlife-associated recreation in Oklahoma, including people that participated in hunting, fishing, and wildlife watching. In total, people spent over $1.8 billion on wildlife recreation in Oklahoma during 2011 (USFWS and the United States Department of Commerce 2011).

If the WS program in Oklahoma implemented an alternative where personnel provide direct assistance with managing damage associated with predators, WS' employees could use lethal and non-lethal methods to target those animals that personnel have identified as causing damage or posing a threat of damage. If the WS program in Oklahoma implemented Alternative 1, WS' personnel could use lethal methods to remove predators from areas where damage or threats were occurring when they determined those methods to be appropriate using the WS Decision Model. WS' personnel would only target those individual animals identified as causing damage or posing a threat of damage after receiving a request for assistance. The WS program in Oklahoma does not engage in the suppression of native wildlife populations nor conducts activities to eradicate any native wildlife species.

As discussed in Section 1.5, the ODWC is responsible for managing resident wildlife species in the State, except those species considered threatened or endangered by the USFWS. The mission of the ODWC "*…is the management, protection, and enhancement of wildlife resources and habitat for the scientific, educational, recreational, aesthetic, and economic benefits to present and future generations of citizens and visitors to Oklahoma*" (ODWC 2016*a*). As discussed previously, WS has submitted and would continue to submit annual activity reports to the ODWC. Therefore, the ODWC has the opportunity to monitor the total removal of predators from all sources.

Similarly, if the WS program implemented non-lethal methods to address damage associated with predators, those non-lethal methods are likely to disperse or exclude those animals from those areas where WS' personnel employed those methods. However, WS' personnel would not employ non-lethal methods over large geographical areas or apply those methods at such intensity that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope that long-term adverse effects would occur to a species' population.

Based on consultation with the ODWC, which is the agency responsible for managing wildlife in the State and whose mission is to maintain wildlife populations for sustained consumptive and non-consumptive use, the implementation of Alternative 1 by the WS program in Oklahoma would not limit the ability of people to conduct recreational activities in the State. The WS program in Oklahoma and the ODAFF would document the lethal removal of predators annually. In consultation with the ODWC, WS and the ODAFF would continue to monitor activities to evaluate effects on the statewide populations of predators.

Alternative 2 – WS Would Address Predator Damage through an Adaptive Integrated Approach Using Only Non-lethal Methods

This alternative would require personnel from the WS program to use only non-lethal methods to resolve damage or threats of damage. WS' personnel would only employ those methods discussed in Appendix B that were non-lethal. No intentional lethal removal of predators would occur by WS. The use of lethal methods could continue under this alternative by other entities or by those persons experiencing damage by predators. The non-lethal methods used or recommended by WS under this alternative would be identical to those non-lethal methods identified in any of the alternatives. As discussed and evaluated previously, non-lethal methods generally have minimal impacts on overall populations of animals since those methods do not harm target species. Therefore, the use of non-lethal methods would not have adverse effects on coyote populations in the State under any of the alternatives.

Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. For example, some livestock producers already use non-lethal methods to reduce predation (NASS 2000, NASS 2001, NASS 2005, NASS 2006, NASS 2011, APHIS Veterinary Services 2008, APHIS Veterinary Services 2012, APHIS Veterinary Services 2015, APHIS Veterinary Services 2017). The NASS (2005) and the APHIS Veterinary Services (2015) reported that Oklahoma sheep producers used non-lethal methods to reduce predator damage, such as night penning, guard dogs, llamas, fencing, other nonlethal methods, donkeys, frequent checks, lamb shed, culling, frightening tactics, bedding change, carrion removal, and herding to reduce predation. The NASS (2011) also reported that Oklahoma cattle producers used guard animals, culling, frequent checks, carcass removal, exclusion fencing, fright tactics, herding, night penning, and other non-lethal methods to reduce predation.

Mitchell et al. (2004) indicated that non-lethal methods to alleviate predation could be effective. However, Mitchell et al. (2004) and others, such as Knowlton et al. (1999), indicate that, although certain non-lethal methods have shown promise, further research is needed to determine their effectiveness and practicality. Non-lethal methods are an important part of the mix of current strategies used to meet the need for action; however, in some cases, the use of only non-lethal methods would not keep damage or threats of damage at a level that would be acceptable to some people. Andelt (1992) reported that about a third of sheep producers using guard dogs indicated that the use of dogs did not reduce their reliance on other predator control techniques or on predator control agencies. Furthermore, livestock losses could increase as coyotes become accustomed to non-lethal practices (Pfiefer and Goos 1982). Green et al. (1994) found that guard dogs decrease in effectiveness over time, possibly due to an increase in coyotes and/or increase in predatory activities. Shivik (2006) provided a comparison of non-lethal tools for managing predation associated with carnivores, including the duration of effectiveness of those non-lethal tools. For example, Shivik (2006) noted that electronic guards would only be effective for 40 to 50 days when used to deter coyotes. When evaluating the effectiveness of fladry to exclude coyotes from livestock pastures in Michigan, Davidson-Nelson and Gehring (2010) found "…*no long-term exclusion of coyotes from fladry-protected livestock pastures*." However, design modification may improve the effectiveness of fladry (Young et al. 2015). Fencing may be cost prohibitive (deCalesta and Cropsey 1978, Thompson 1979, Nass and Theade 1988).

Implementation of many non-lethal method recommendations would be the responsibility of resource managers. For example, many non-lethal methods available to alleviate damage or threats to livestock associated with coyotes, such as livestock management practices (*e.g.*, night-penning, herding, carcass removal) and physical exclusion (*e.g.*, predator-proof fencing), are not practical for implementation by WS' personnel. Implementation of most non-lethal methods for livestock protection falls within the purview of the livestock producer (Knowlton et al. 1999). The continued use of many non-lethal methods can often lead to the habituation of predators to those methods, which can decrease the effectiveness of those methods. Therefore, those persons experiencing damage or threats of damage associated with predators may seek assistance with the use of available lethal methods.

Other entities could continue to use lethal methods under this alternative. If those non-lethal methods employed by the WS program did not reduce damage or threats of damage to levels acceptable to the requester, the requester could seek assistance from the ODAFF, the ODWC, other entities, or could conduct damage management activities on their own. In some cases, property owners or managers may misuse some methods or use some methods in excess of what was necessary, which could then become hazardous and pose threats to the safety of people and wildlife species. People have resorted to the illegal use of chemicals and methods to alleviate the damage that animals cause (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015).

The WS program could refer those persons experiencing damage or threats of damage to the ODAFF, the ODWC, and/or to other entities for information and implementation of lethal methods. Therefore, if other entities increased their efforts to manage damage caused by predators in proportion to those activities that the WS program would have conducted using lethal methods, the potential effects on target predator populations would be similar to Alternative 1.

Alternative 3 – Predator Damage Management by WS through Technical Assistance Only

Under a technical assistance only alternative, WS would recommend an integrated methods approach similar to Alternative 1; however, WS would not provide direct operational assistance under this alternative. Therefore, this alternative would place the immediate burden of resolving damage on the people requesting assistance. Using information that a requester provides or from a site visit by an employee, WS would recommend methods and techniques based on the application of the WS Decision Model. In some instances, information provided to the requester by WS could result in tolerance/acceptance of the situation. In other instances, WS would discuss and recommend damage management options.

When WS discussed damage management options with the person requesting assistance, WS could recommend and demonstrate for use both non-lethal and lethal methods legally available for use to alleviate predator damage. Those persons receiving technical assistance from WS could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from other entities, or take no further action.

Despite WS not providing direct operational assistance to resolve damage and threats associated with predators, those people experiencing damage caused by predators could continue to alleviate damage by employing those methods legally available or by seeking assistance from other entities. Appendix B discusses the methods available for use in managing damage and threats associated with predators. Similar to Alternative 1, those methods described in Appendix B would be available to those persons experiencing damage or threats associated with predators in the State; however, immobilizing drugs, euthanasia chemicals, sodium cyanide (M-44 device), and the use of aircraft would have limited availability to the public and other entities under this alternative and under Alternative 4. However, other entities could register sodium cyanide (M-44 device) for use in the State under this alternative. In addition, the ODAFF could issue permits for the operation and use of private aircraft to assist with the management of wildlife damage; therefore, other entities could pursue the use of aircraft.

Title 29, Chapter 1, Article 5, Section 5-405 of the OS states, "*Nothing contained in these provisions shall prevent the killing of furbearers actually found destroying livestock, poultry or exotic livestock*…". In addition, the ODWC can also issue permits to people experiencing damage associated with wildlife. People can harvest coyotes and striped skunks throughout the year in the State and can harvest badgers, black bears, bobcats, gray fox, raccoons, red fox, river otters, Virginia opossum, long-tailed weasels, and mink during annual hunting and/or trapping seasons. Management actions taken by non-federal entities would represent the *environmental status quo* (see Section 2.1).

Therefore, those persons experiencing threats or damage associated with predators in the State could lethally remove those species or request assistance from other entities despite WS' lack of direct involvement in the management action. The WS program in Oklahoma would have no direct effect on predator populations from a program implementing technical assistance only. The number of predators lethally removed annually would likely be similar to the other alternatives. Local predator populations could decline, stay the same, or increase depending on actions taken by those persons experiencing predator damage. WS' participation in a management action would not be additive to an action that would occur in the absence of WS' participation.

With the oversight of the ODWC, it is unlikely that damage management activities conducted by other entities would adversely affect native predator populations by implementation of this alternative by WS. Under this alternative, other entities could provide damage management actions and direct operational assistance, such as the ODAFF, the ODWC, and/or private entities. If direct operational assistance was not available from WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal removal, which could lead to real but unknown effects on the population of predators and other wildlife. People have resorted to the illegal use of chemicals and methods to alleviate the damage that predators cause (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015).

Alternative 4 – No Predator Damage Management Conducted by WS

Under this alternative, WS would have no direct involvement with any aspect of addressing damage caused by predators and would provide no technical assistance. No removal of predators by WS would occur under this alternative. While WS would provide no assistance under this alternative, other individuals or entities could conduct lethal damage management resulting in lethal removal levels similar to Alternative 1. WS would refer all requests for assistance associated with predators to other entities, such as the ODAFF, the ODWC, and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with predators in the State, those people experiencing damage caused by predators could continue to alleviate damage by employing both non-lethal and lethal methods. Similar to the other alternatives, those methods described in Appendix B would be available to those persons experiencing damage or threats associated with predators in the State; however, immobilizing drugs, euthanasia chemicals, sodium cyanide (M-44 devices), and the use of aircraft would have limited availability to the public and other entities under this alternative. Like the other alternatives, the use of non-lethal methods by those entities experiencing damage associated with predators or their agents would not occur at such levels that adverse effects would occur to the populations of those species in the State.

Similar to all the alternatives, people could continue to alleviate damage by lethally removing predators similar to Alternative 3. The number of predators that other entities would lethally remove annually under this alternative would be unknown but could be similar to the other alternatives. Therefore, local predator populations could decline, stay the same, or increase depending on actions taken by those persons experiencing coyote damage. Management actions taken by non-federal entities would represent the *environmental status quo*.

Some resource/property owners may take illegal, unsafe, or environmentally harmful action against local populations of predators out of frustration or ignorance. In the past, people have resorted to the illegal use of chemicals and methods to alleviate the damage that predators cause (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015).

The number of predators that other entities would lethally remove annually under this alternative would be unknown but could be similar to the other alternatives. Local predator populations could decline, stay the same, or increase depending on actions taken by those persons experiencing predator damage. Since other entities could still remove predators under this alternative, the potential effects on predator populations in the State would be similar to the other alternatives for this issue. WS' involvement would not be additive to removal that could occur since the cooperator requesting WS' assistance could conduct predator damage management activities without WS' direct involvement. Therefore, any actions to resolve damage or reduce threats associated with predators could occur by other entities despite WS' lack of involvement under this alternative.

Issue 2 - Effects of Predator Damage Management Activities on the Populations of Non-target Wildlife Species, Including T&E Species

As discussed previously, a concern would be the potential impacts to non-target species, including T&E species, from the use of methods to resolve damage caused by predators. Non-target species could be killed unintentionally during damage management activities whether implemented by WS, other agencies, or the public. Discussion on the potential effects of the alternatives on the populations of non-target animal species, including T&E species, occurs below.

Alternative 1 - Continue the Current Adaptive Integrated Methods Approach to Managing Predator Damage (No Action/Proposed Action)

The potential for adverse effects to non-targets occurs from the employment of methods to address predator damage. Under this alternative, WS could provide both technical assistance and direct operational assistance to those people requesting assistance. The risks to non-targets from the use of non-lethal methods, as part of an integrated direct operational assistance program, would be similar to those risks to non-targets discussed in the other alternatives.

Personnel from WS would have experience with managing animal damage and would receive training in the employment of methods, which would allow WS' employees to use the WS Decision Model to select the most appropriate methods to address damage caused by targeted predators and to exclude non-target species. To reduce the likelihood of capturing non-target wildlife, WS would employ the most selective methods for the target species, would employ the use of attractants that were as specific to target species as possible, and determine placement of methods to avoid exposure to non-targets. A discussion of the SOPs to prevent and reduce any potential adverse effects on non-targets occurs in Chapter 3 of this EA. Despite the best efforts to minimize non-target exposure to methods during program activities, the potential for WS to disperse or lethally remove non-targets exists when applying both non-lethal and lethal methods to manage damage or reduce threats to safety.

Non-lethal methods have the potential to cause adverse effects to non-targets primarily through exclusion, harassment, and dispersal. Any exclusionary device erected to prevent access by predators also potentially excludes species that were not the primary reason for erecting the exclusion; therefore, exclusion methods potentially could adversely affect non-target species if the area excluded was large enough. The use of auditory and visual dispersal methods to reduce damage or threats caused by predators would also likely disperse non-targets in the immediate area the methods were employed. Therefore, non-targets may disperse permanently from an area while employing non-lethal dispersal techniques. However, like target species, the potential impacts on non-target species would likely be temporary with target and non-target species often returning after the cessation of dispersal methods.

Non-lethal methods that use auditory and visual stimuli to reduce or prevent damage elicit fright responses in animals. When employing those methods to disperse or harass target species, any non-targets nearby when employing those methods would also likely disperse from the area. Similarly, any exclusionary device constructed to prevent access by predators could also exclude access to some non-target species. The persistent use of non-lethal methods would likely result in the dispersal or abandonment of those areas where non-lethal methods were employed of both predators and non-target species. Therefore, any use of non-lethal methods would likely elicit a similar response from both non-target and target predators. Although non-lethal methods do not result in the lethal removal of non-targets, the use of non-lethal methods could restrict or prevent access of non-targets to beneficial resources. However, long-term adverse effects would not occur to a species' population since WS would not employ non-lethal methods over large geographical areas or at such intensity levels that resources (*e.g*., food sources, habitat) would be unavailable for extended durations or over a wide geographical scope. Non-lethal methods would generally have minimal impacts on overall populations of animals since individuals of those species were unharmed. Overall, the use of non-lethal methods would not adversely affect populations of animals since those methods would often be temporary.

Other non-lethal methods available for use under this alternative would include live traps and immobilizing drugs. Live traps restrain animals once captured; therefore, those methods are live-capture methods. Live traps would have the potential to capture non-target species. Trap placement in areas where target predators were active and the use of target-specific attractants would likely minimize the capture of non-targets. Attending to traps appropriately would allow the release of any non-targets captured unharmed.

WS could employ immobilizing drugs to handle and transport predators. WS' personnel would apply immobilizing drugs directly to target animals through hand injection or by projectile (*e.g*., dart gun). WS would make reasonable efforts to retrieve projectiles containing immobilizing drugs if misses occurred or if the projectile detached from target animals. Therefore, no direct effects to non-target animals would be likely since identification would occur prior to application. Animals anesthetized using immobilizing drugs recover once the animal has fully metabolized the drug. Therefore, non-targets that may consume animals that recover are unlikely to receive a dosage that would cause any impairment. When using immobilizing drugs to handle or transport target animals, WS would monitor anesthetized animals until that animal recovers sufficiently to leave the site.

Potential impacts to non-targets from the use of non-lethal methods would be similar to the use of non-lethal methods under any of the alternatives. Non-targets would generally be unharmed from the use of non-lethal methods under any of the alternatives since no lethal removal would occur. Non-lethal methods would be available under all the alternatives analyzed. Using the WS Decision Model, WS' personnel would consider the potential effects to non-targets from the potential use of non-lethal methods. Potential impacts to non-targets under this alternative from the use of and/or the recommendation of non-lethal methods are likely to be low.

WS' personnel could also employ and/or recommend lethal methods under Alternative 1 to alleviate damage, when employees, using the WS Decision Model, deemed those methods appropriate for use. Lethal methods available for use to manage damage caused by predators under this alternative would include the recommendation of harvest during the hunting and/or trapping season, shooting, cable devices, euthanasia chemicals, fumigants (coyotes, red fox, striped skunks only), sodium cyanide (coyotes, fox, feral dogs only), and euthanasia after live-capture. Available methods and the application of those methods to resolve predator damage is further discussed in Appendix B.

The use of firearms would essentially be selective for target predators since WS' personnel would identify animals prior to application; therefore, WS does not anticipate any adverse effects from use of this method. Similarly, the use of euthanasia methods would not result in non-target removal since identification would occur prior to euthanizing an animal.

When using gas cartridges, burrows and dens would be observed for the presence of non-targets before the use of gas cartridges. If non-target activity (*e.g.*, tracks, scat) were observed, the fumigation of those burrows or dens would not occur. Since non-targets are known to occur in burrows or dens, some risks of unintentional removal of non-targets does exist from the use of gas cartridges. WS' personnel would only use gas cartridges in active burrows or dens only, which would minimize risk to non-targets. Risks to non-targets can be minimized by treating only burrows that appear to be active (Dolbeer et al. 1991). There are no secondary poisoning risks involved with the use of gas cartridges as the gas produced dissipates into the atmosphere shortly after activation. Primary risks to non-targets would be minimized by treating only active burrows or dens, by covering entrances of burrows or dens, and by following the pesticide label. Although non-targets could be present in burrows or dens, even after WS' conducts site investigations, the risks would be relatively low and unintentional removal from the use of gas cartridges would be limited.

WS' personnel would place and use cable devices, fumigants (coyotes, red fox, striped skunks only), and sodium cyanide (coyotes, fox, feral dogs only) in such a manner as to minimize the threat to non-target species by placement in those areas frequently used by target animals, using baits or lures that are as species specific as possible, and modification of individual methods to exclude non-targets from being unintentionally removed. Shivik et al. (2014) found M-44 devices using sodium cyanide capsules to be highly selective toward killing canid species. The recommendation of harvest during the hunting/trapping season would not increase risks to non-targets beyond those associated with normal hunting/trapping activities.

An issue that has arisen is the potential for low-level flights to disturb wildlife, including T&E species. Aerial operations could be an important method of damage management in Oklahoma when used to address damage or threats associated with coyotes in remote areas. Aerial operations involving shooting would only occur in those areas where WS and the property owner/manager signed a work initiation document allowing the use of aircraft. WS could also use aircraft for aerial surveys of wildlife or radio telemetry. The amount of time spent conducting aerial operations would vary depending on the survey area, severity of damage, the size of the area where damage or threats were occurring, and the weather, as low-level aerial activities would be restricted to visual flight rules and would be impractical in high winds or at times when animals were not easily visible.

Aircraft play an important role in the management of various wildlife species for many agencies. Resource management agencies rely on low flying aircraft to monitor the status of many animal populations, including large mammals (Lancia et al. 2000), birds of prey (Fuller and Mosher 1987), waterfowl (Bellrose 1976), and colonial waterbirds (Speich 1986). Low-level flights also occur when entities use aircraft to track animal movements by radio telemetry (Gilmer et al. 1981, Samuel and Fuller 1996).

A number of studies have looked at responses of various wildlife species to aircraft overflights. The National Park Service (1995) reviewed the effects of aircraft overflights on wildlife and suggested that adverse effects could occur to certain species. Some species will frequently or at least occasionally show an adverse response to even minor overflights. In general though, it appears that the more serious potential adverse effects occur when overflights are chronic (*i.e.*, they occur daily or more often over long periods). Chronic exposures generally involve areas near commercial airports and military flight training facilities. Aerial operations conducted by WS rarely occur in the same areas on a daily basis, and aircraft used by WS actually spend little time flying over those particular areas.

The effects on wildlife from military-type aircraft have been studied extensively (Air National Guard 1997), and were found to have no expected adverse effects on wildlife. Examples of species or species groups that people have studied with regard to the issue of aircraft-generated disturbance are as follows.

WATERBIRDS AND WATERFOWL: Low-level overflights of two to three minutes in duration by a fixed-wing airplane and a helicopter produced no "*drastic*" disturbance of tree-nesting colonial waterbirds, and, in 90% of the observations, the individual birds either showed no reaction or merely looked up (Kushlan 1979). Belanger and Bedard (1989, 1990) observed responses of greater snow geese (*Chen caerulescens atlantica*) to man-induced disturbance on a sanctuary area and estimated the energetic cost of such disturbance. Belanger and Bedard (1989, 1990) observed that disturbance rates exceeding two per hour reduced goose use of the sanctuary by 50% the following day. They also observed that about 40% of the disturbances caused interruptions in feeding that would require an estimated 32% increase in nighttime feeding to compensate for the energy lost. They concluded that managers should strictly regulate overflights of sanctuary areas to avoid adverse effects. Conomy et al. (1998) quantified behavioral responses of wintering American black ducks (*Anas rubripes*), American wigeon (*A. americana*), gadwall (*A. strepera*), and American green-winged teal (*A. crecca carolinensis*) exposed to low-level military aircraft and found that only a small percentage (2%) of the birds reacted to the disturbance. They concluded that such disturbance was not adversely affecting the "*time-activity budgets*" of the species. Low-level aerial operations conducted by WS would not occur over federal, state, or other governmental agency property without the concurrence of the managing entity. If requested, WS would conduct those flights to reduce threats and damages occurring to natural resources, which should not result in impacts to bird species. Thus, there is little to no potential for any adverse effects on waterbirds and waterfowl.

RAPTORS: The Air National Guard analyzed and summarized the effects of overflight studies conducted by numerous federal and state government agencies and private organizations (Air National Guard 1997). Those studies determined that military aircraft noise initially startled raptors, but negative responses were brief and did not have an observed effect on productivity (see Ellis 1981, Fraser et al. 1985, Lamp 1989, United States Forest Service 1992 as cited in Air National Guard 1997). A study conducted on the impacts of overflights to bald eagles (*Haliaeetus leucocephalus*) suggested that the eagles were not sensitive to this type of disturbance (Fraser et al. 1985). During the study, observations were made of more than 850 overflights of active eagle nests. Only two eagles rose out of either their incubation or brooding postures. This study also showed that perched adults were flushed only 10% of the time during aircraft overflights. Evidence also suggested that golden eagles (*Aquila chrysaetos*) were not highly sensitive to noise or other aircraft disturbances (Ellis 1981, Holthuijzen et al. 1990). Finally, one other study found that eagles were particularly resistant to disturbances flushing them from their nests (see Awbrey and Bowles 1990 as cited in Air National Guard 1997). Therefore, there is considerable evidence that overflights during aerial operations would not adversely affect eagles.

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

Andersen et al. (1989) conducted low-level helicopter overflights directly at 35 red-tailed hawk (*Buteo jamaicensis*) nests and concluded their observations supported the hypothesis that red-tailed hawks habituate to low level flights during the nesting period since results showed similar nesting success between hawks subjected to overflights and those that were not. White and Thurow (1985) did not evaluate the effects of aircraft overflights, but found that ferruginous hawks (*B. regalis*) were sensitive to certain types of ground-based human disturbance to the point that reproductive success may be adversely affected. However, military jets that flew low over the study area during training exercises did not appear to bother the hawks, nor did the hawks become alarmed when the researchers flew within 100 feet in a small fixed-wing aircraft (White and Thurow 1985). White and Sherrod (1973) suggested that disturbance of raptors by aerial surveys with helicopters may be less than that caused by approaching nests on foot. Ellis (1981) reported that five species of hawks, two falcons (*Falco* spp.), and golden eagles (*Aquila chrysaetos*) were "*incredibly tolerant*" of overflights by military fighter jets, and observed that, although birds frequently exhibited alarm, negative responses were brief and the overflights never limited productivity.

Grubb et al. (2010) evaluated golden eagle response to civilian and military (Apache AH-64) helicopter flights in northern Utah. Study results indicated that golden eagles exposed to flights ranging from 100 to 800 meters along, towards, and from behind occupied cliff nests did not adversely affect eagle courtship, nesting, and fledglings, indicating that no special management restrictions were required in the study location.

The above studies indicate raptors were relatively unaffected by aircraft overflights, including those by military aircraft that produce much higher noise levels. Therefore, aerial operations would have little or no potential to affect raptors adversely.

PASSERINES: Reproductive losses have been reported in one study of small territorial passerines ("*perching*" birds that included sparrows, blackbirds) after exposure to low altitude overflights (see Manci et al. 1988 as cited in Air National Guard 1997), but natural mortality rates of both adults and young are high and variable for most species. The research review indicated passerine birds cannot be driven any great distance from a favored food source by a non-specific disturbance, such as military aircraft noise, which indicated quieter noise would have even less effect. Passerines avoid intermittent or unpredictable sources of disturbance more than predictable ones, but return rapidly to feed or roost once the disturbance ceases (Gladwin et al. 1988, United States Forest Service 1992). Those studies and reviews indicated there is little or no potential for aerial operations to cause adverse effects on passerine bird species.

PRONGHORN (ANTELOPE) AND MULE DEER: Krausman et al. (2004) found that Sonoran pronghorn (*Antilocapra americana sonoriensis*) were not adversely affected by military fighter jet training flights and other military activity on an area of frequent and intensive military flight training operations. Krausman et al. (1986) reported that only three of 70 observed responses of mule deer (*Odocoileus hemionus*) to small fixed-wing aircraft overflights at 150 to 500 feet above ground level resulted in the deer changing habitats. The authors believed that the deer might have been accustomed to overflights because the study area was near an interstate highway that aircraft frequently followed. Krausman et al. (2004) also reported that pronghorn and mule deer do not hear noise from military aircraft as well as people, which potentially indicates why they appeared not to be disturbed as much as previously thought.

MOUNTAIN SHEEP: Krausman and Hervert (1983) reported that, of 32 observations of the response of mountain sheep to low-level flights by small fixed-wing aircraft, 60% resulted in no disturbance, 81% in no or "*slight*" disturbance, and 19% in "*great*" disturbance. Krausman and Hervert (1983) concluded that flights less than 150 feet above ground level could cause mountain sheep to leave an area. When Weisenberger et al. (1996) evaluated the effects of simulated low altitude jet aircraft noise on desert mule deer (*Odocoileus hemionus crooki*) and mountain sheep (*Ovis canadensis mexicana*), they found that heart rates of the ungulates increased according to the dB levels, with lower noise levels prompting lesser increases. When they were elevated, heart rates rapidly returned to pre-disturbance levels suggesting that the animals did not perceive the noise as a threat. Responses to the simulated noise levels decreased with increased exposure.

BISON: Fancy (1982) reported that only two of 59 bison (*Bison bison*) groups showed any visible reaction to small fixed-winged aircraft flying at 200 to 500 feet above ground level. The study suggests that bison were relatively tolerant of aircraft overflights.

DOMESTIC ANIMALS AND SMALL MAMMALS: A number of studies with laboratory animals (*e.g*., rodents [Borg 1979]) and domestic animals (*e.g*., sheep [Ames and Arehart 1972]) have shown that these animals can habituate to noise. Long-term lab studies of small mammals exposed intermittently to high levels of noise demonstrate no changes in longevity. The physiological "*fight or flight*" response, while marked, does not appear to have any long-term health consequences on small mammals (Air National Guard 1997). Small mammals habituate, although with difficulty, to sound levels greater than 100 dbA (United States Forest Service 1992).

Although some of those wildlife species discussed above are not present in Oklahoma, the information demonstrates the relative tolerance most wildlife species have of overflights, even those that involve noise at high decibels, such as from military aircraft. In general, the greatest potential for impacts to occur exists when overflights are frequent, such as hourly and over many days that could represent "*chronic*" exposure. Chronic exposure situations generally involve areas near commercial airports and military flight training facilities. Even then, many wildlife species often habituate to overflights, which would naturally minimize any potential adverse effects where such flights occur on a regular basis. Therefore, aircraft used by WS should have far less potential to cause any disturbance to wildlife than military aircraft because the military aircraft produce much louder noise and would be flown over certain training areas many more times per year, and yet were found to have no expected adverse effects on wildlife (Air National Guard 1997).

WS would only conduct aerial activities on a very small percentage of the land area of the State, which indicates that WS would not even expose most wildlife to aerial overflights. Further lessening the potential for any adverse effects would be that such flights occur infrequently throughout the year.

EFFECTS ON NON-TARGET ANIMAL POPULATIONS FROM WS' PREVIOUS ACTIVITIES

While WS' personnel take precautions to safeguard against capturing non-target animals during operational use of methods and techniques, the use of such methods can result in the unintentional live-capture or lethal removal of unintended species. In accordance with WS' policy (see WS Directive 2.101, WS Directive 2.450, WS Directive 2.455), WS' personnel take precautions to minimize the risk of capturing or lethally removing non-target animals. Some precautions that WS' personnel could take to minimize the risk of capturing non-target animals include selective trap placement, proper site selection, breakaway locks on cable devices (Phillips et al. 1990, Phillips and Blom 1991), trap pan-tension devices on foothold traps (Phillips and Gruver 1996), and adjusting the trigger position on body-grip traps (Association of Fish and Wildlife Agencies 2014). Nevertheless, WS has captured or lethally removed some non-target animals unintentionally during activities conducted to alleviate damage.

Table 4.1 shows the number of non-target animals lethal removed unintentionally during activities conducted by WS from FY 2009 through FY 2016. To ensure a cumulative evaluation occurs, Table 4.1 includes non-target animals lethally removed unintentionally during activities associated with managing damage caused by aquatic rodents that could overlap with non-target animals lethally removed during activities targeting those predator species addressed in this EA. For example, most of the river otter lethally removed unintentionally by WS between FY 2009 and FY 2016 were associated with activities being conducted to alleviate damage caused by beaver. However, those species included in Table 4.1 could also be lethally removed unintentionally during activities conducted under the proposed action alternative described in this EA since many of same methods would be available for use to alleviate damage or threats of damage.

Table 4.1 – WS' lethal removal of non-target animals in Oklahoma, FY 2009 – FY 2016†

Species	Method of Lethal Removal					Total	Mean
	M-44 Device	Body-Grip Trap	Cage Trap‡	Foothold Trap	Neck Snare		
Badger	0	0	0	4	1	**5**	1
Bobcat	0	0	0	10	3	**13**	2
Coyote	0	0	0	2	1	**3**	0.4
Feral Cat	0	0	0	1	0	**1**	0.1
Feral Dog	112	0	0	2	26	**140**	18
Gray Fox	2	0	0	2	1	**3**	1
Red Fox	2	0	0	1	1	**4**	1
Striped Skunk	30	0	3	5	7	**45**	6
Mink	0	1	0	0	0	**1**	0.1
Raccoon	21	4	0	65	42	**132**	17
River Otter	0	274	0	0	0	**274**	34
Virginia Opossum	63	0	2	11	8	**84**	11

†Includes non-targets lethally removed unintentionally during activities associated with managing damage caused by aquatic rodents (USDA 2015*a*) that overlap with non-targets lethally removed during activities targeting those predator species addressed in this EA

‡Animals were dispatched with firearms to minimize safety concerns of personnel with the release of animals

Table 4.2 shows those non-target animals live-captured and released unharmed by WS from FY 2009 through FY 2016. Similar to Table 4.1, Table 4.2 includes non-target animals live-captured unintentionally but released during activities associated with other WS activities. However, those species could also be live-captured and released during activities conducted under Alternative 1.

Table 4.2 – Non-targets live-captured and released by WS in Oklahoma, FY 2009 – FY 2016†

Species	Method of Live-Capture			Total
	Cage Trap	Foothold‡	Snare‡	
Badger	0	2	0	**2**
Bobcat	0	1	0	**1**
Feral Cats	3	1	0	**4**
Feral Dogs	1	17	17	**35**
Raccoon	2	2	4	**8**
Opossum	12	0	1	**13**

‡Animals captured in foothold traps, or neck snares by the tail or other extremity would be released if they are unharmed and can be released safely.

EFFECTS ON NON-TARGET ANIMAL POPULATIONS UNDER ALTERNATIVE 1

Under Alternative 1, WS' personnel would continue to take precautions to minimize the risk of capturing or lethally removing non-target animals, including those SOPs discussion in Section 3.3 and Section 3.4 of this EA. Despite those precautions and SOPs, the use of some methods could continue to result in the unintentional live-capture or lethal removal of unintended species. The unintentional removal and capture of animal species during damage management activities conducted under this alternative would primarily be associated with the use of M-44 devices, body-gripping traps, and cable devices and in some situations, with live-capture methods, such as foothold traps and cage traps (see Table 4.1 and Table 4.2).

WS would monitor the removal of non-target species to ensure program activities or methodologies used in predator damage management would not adversely affect the populations of non-target species. Methods available to resolve and prevent predator damage or threats when employed by trained, knowledgeable personnel would be relatively selective for target species. WS would report to the ODWC any non-target animals lethally removed to ensure the ODWC had the opportunity to consider that removal as part of management objectives established for those species by the ODWC. The potential for adverse effects to occur to a population of a non-target species would be similar to the other alternatives and would be considered minimal to non-existent based on previous the limited removal that has occurred previously by WS.

As discussed previously, the use of non-lethal methods to address damage or threats generally have no effect on a species' population since those individuals addressed using non-lethal methods would be unharmed and no actual reduction in the number of individuals in a species' population occurs. Similarly, the live-capture and release of non-target animals generally has no adverse effects on a species' population since those individuals would be released unharmed and no actual reduction in the number of individuals in a population occurs. Therefore, the live-capture and subsequent releasing of non-target animals during damage management activities conducted under Alternative 1 would not result in declines in the number of individuals in a species' population.

While the WS program would take precautions to safeguard against taking non-target animals during operational use of methods and techniques for resolving damage and reducing threats caused by predators, the use of such methods could result in the incidental removal of unintended species. Those occurrences would be rare and should not affect the overall populations of any species under the proposed action.

The lethal removal of non-target animals could result in declines in the number of individuals in a population; however, as was discussed previously, the lethal removal of non-target animals by WS during damage management activities would be of low magnitude when compared to the actual statewide population of those species. The previous non-target animals lethally removed unintentionally by WS are representative of non-target animals that WS' personnel could lethally remove under Alternative 1. Although personnel could lethally remove additional species of non-target animals, the removal of individuals from any species would not be likely to increase substantively above the number of non-target animals removed annually by WS during previous damage management activities.

Therefore, WS expects the potential effects of implementing Alternative 1 would be similar to those effects that have occurred previously. In addition, many of the species that WS could capture or lethally remove unintentionally during the implementation of Alternative 1 are species that people have requested assistance with from WS. The analyses of potential effects on a species population that occurred under Issue 1 in Section 4.1 of this EA include the cumulative removal that could occur under Alternative 1, including those individuals of a species that WS could remove intentionally to alleviate damage or that WS could remove unintentionally during activities targeting other animals. Since Alternative 1 would be a continuation of the current program of using an adaptive integrated methods approach to managing damage, WS expects the magnitude of cumulative removal of target animals and non-target animals to be similar to WS' previous activities conducted between FY 2009 and FY 2016. WS would continue to monitor activities, including non-target animal removal, to ensure the annual removal of non-target animals does not result in adverse effects to a species' population.

Another concern that some members of the public have expressed previously is a concern that the presence of WS' personnel in the field during the spring months and the potential to cause harmful disturbance to wildlife by causing some animals to separate from their mothers or cause the abandonment of nest sites of birds. The State of Oklahoma covers approximately 69,900 square miles (44,735,360 acres), which includes 68,600 square miles of land (43,900,800 acres) and 1,300 square miles of water (834,560 acres) (United States Census Bureau 2010). Vincent et al. (2014) indicated that of the total surface area of Oklahoma, federal land comprised 701,400 acres. In 2012, the USDA (2014) estimated there were nearly 34.4 million acres of farmland and farm-related activities. On those farmlands in Oklahoma, nearly 11.3 million acres were classified as cropland in 2012, 789,400 acres were classified as Conservation Reserve Program lands, and 19.5 million acres were classified as pastureland or rangeland (USDA 2014). Therefore, most of the land area in Oklahoma is privately owned and used for agricultural purposes and subject to normal agricultural practices (*e.g.*, planting crops, mowing, checking on livestock, checking on fences).

WS' activities, on an annual average, occur on approximately 4.5% of the total surface area of Oklahoma. Therefore, most of the actual land area in the State is not subjected to any activities conducted by WS' personnel. In addition, the frequency and duration of field activities that WS' personnel conducted throughout the land area was low. During FY 2014, WS' personnel statewide spent in excess of 16,000 hours on properties conducting damage management activities related to predators. Of that total time, approximately 4,300 hours were spent conducting damage management activities related to predators during the months of March, April, and May, which is generally the time of the year when most species have young that could be vulnerable to separation or abandonment because of disturbance. On a particular property, a WS' employee would only actually walk or drive on a very small percentage of the area of the property to check for sign of the responsible predator species, to employ methods, and to check methods. For example, a landowner may allow WS to conduct activities on the 100 acres they own but WS' personnel might only conducted activities on 10 acres of the property. Therefore, only a small proportion of an individual property would be subject to the actual presence or close-proximity foot traffic or vehicle traffic by a WS employee. Low-level aerial flights over a property would also occur infrequently, with limited duration, and would occur over only a small percentage of the land area. Based on the small amount of relative land area that WS could conduct activities, should mean WS' activities would not result in any effects on populations of non-target wildlife species.

ANALYSIS OF RISKS TO THREATENED AND ENDANGERED SPECIES

WS would make special efforts to avoid jeopardizing T&E species through biological evaluations of potential effects and the establishment of special restrictions or minimization measures through consultation with the USFWS, when appropriate. The WS program has established guidelines for activities conducted by personnel associated with threatened or endangered species (see WS Directive 2.310). Chapter 3 of this EA describes several SOPs to avoid effects to T&E species.

Federally Listed Species – As part of the development of the EA, WS consulted with the USFWS pursuant to Section 7 of the ESA. As part of that consultation process, WS conducted a review of potential impacts of Alternative 1 on each of the species listed at the time WS and the ODAFF developed the EA. The evaluation took into consideration the direct and indirect effects of available methods. As part of the review process, WS prepared and submitted a biological assessment to the USFWS as part of the consultation process pursuant to Section 7 of the ESA. WS determined that the proposed activities "*may affect*" those species but those effects would be solely beneficial, insignificant, or discountable, which would warrant a "*not likely to adversely affect*" determination. In addition, WS determined the implementation of Alternative 1 would have no effect on any critical habitat currently designated in Oklahoma. The USFWS concurred with WS' effects determination (J. Polk, USFWS pers. comm. 2017).

No take of threatened or endangered species has occurred by the WS program or the ODAFF during activities to alleviate damage caused by predators. The WS program and the ODAFF would continue to implement those SOPs identified in Section 3.3 and Section 3.4 of this EA. WS and the ODAFF would continue to review the list of species in Oklahoma on the Federal List of Endangered and Threatened Wildlife.

Table 4.3 - Threatened and endangered species listed by the USFWS and present in Oklahoma

SPECIES	SCIENTIFIC NAME	Status	Locale	Habitat
MAMMALS				
Bat, gray	*Myotis grisescens*	E	Northeast	CF
Bat, Indiana	*Myotis sodalis*	E	East	CF
Bat, Ozark big-eared	*Corynorhinus townsendii ingens*	E	Northeast	CF
Bat, Northern long-eared	*Myotis septentionalis*	T	Eastern	CF
BIRDS				
Crane, whooping	*Grus americana*	E,H	All	GW
Plover, piping	*Charadrius melodus*	T	All	LW
Tern, Interior least	*Sterna antillarum*	E	All	LW
Vireo, black-capped	*Vireo atricapillus*	E	Central	FG
Woodpecker, red-cockaded	*Picoides borealis*	E	Southeast	F
Knot, Red	*Calidris canutus rufa*	T	All	LW
REPTILES				
American Alligator	*Alligator mississipiensis*	T*	Southeast	LW
FISHES				
Cavefish, Ozark	*Amblyopsis rosae*	T	Northeast	C
Darter, leopard	*Percina pantherina*	T,H	Southeast	W
Madtom, Neosho	*Noturus placidus*	T	Northeast	W
Shiner, Arkansas River	*Notropis girardi*	T,H	West	LW
INVERTEBRATES				
Beetle, American burying	*Nicrophorus americanus*	E	East	FG
Moth, Rattlesnake-master borer	*Papaipema eryngii*	C	Northeast	G
Mucket, Neosho	*Lampsilis rafinesqueana*	E,H	Northeast	LW
Mussel, scaleshell	*Arkansia wheeleri*	E	Southeast	W
Pocketbook, Ouachita rock	*Leptodea leptodon*	E	Southeast	LW
Rabbitsfoot	*Quadrula cylindrica cylindrica*	T,H	East	LW
Mapleleaf, winged	*Quadrula fragosa*	E	East	LW
PLANTS				
Harperella	*Ptilimnium nodosum*	E	East	W

STATUS
E *- Endangered*
T *- Threatened*
C *- Candidate*
H *– Design. Crit. Hab.*
******* *- Similarity of Appearance*

HABITAT
C *- Caves*
F *- Forests/riparian borders*
G *- Grassland/range/meadow*
L *- Lakes, Rivers*
W *- Wetland/marsh/creek*

State Listed Species - The current list of State listed species as endangered or threatened as determined by the ODWC was obtained and reviewed during the development of the EA (see Table 4.4). Based on the review of species listed in the State, WS has determined that the proposed activities will have no effect on those species currently listed by the State. WS and the ODAFF would continue to review the species listed as threatened or endangered by the ODWC. As appropriate, the WS program in Oklahoma would continue to consult with the ODWC when WS determines activities may affect a threatened or endangered species designated by the ODWC.

Table 4.4 - Threatened and endangered species listed by the ODWC and present in Oklahoma

SPECIES	SCIENTIFIC NAME	Status	Locale	Habitat
FISHES				
Darter, Long-nosed	*Percina nasuta*	E	Northeast	L
Darter, Black-sided	*Percina maculata*	T	East	L
INVERTEBRATES				
Mucket, Neosho	*Lampsilis rafinesqueana*	E	Northeast	LW
Crayfish, Oklahoma Cave	*Cambarus tartarus*	E	Northeast	C

STATUS
E *- Endangered*
T *- Threatened*

HABITAT
C *- Caves*
L *- Lakes, Rivers*
W *- Wetland/marsh/creek*

POTENTIAL FOR ACTIVITIES TO IMPACT BIODIVERSITY AND ECOSYSTEM RESILIENCE

Biodiversity refers to the variety of species within an ecosystem. Ecosystem resilience refers to the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes that control behavior (Westman 1978, Gunderson 2000). It also refers to the ability of species and ecosystems to withstand unpredictable fluctuations in environmental conditions (*e.g*., drought) without jeopardizing species survival or changes in ecosystem structure (Gunderson 2000). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes et al. 2011). In a diverse ecosystem, there is often redundancy in the roles that species have 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 can be more susceptible to adverse impacts and stressors, such as climate change, disease outbreaks, and the introduction of invasive species (Crooks and Soulé 1999, Ritchie and Johnson 2009, Estes et al. 2011, Beschta et al. 2013, Bergstrom et al. 2014).

Predators can influence ecosystems directly through predation and exclusion/reduction in populations of other predators/mesopredators. In addition, predators can influence ecosystems indirectly by altering prey behavior and habitat use, by limiting the abundance of prey species, and by altering the affect those species have on other levels of the food web (Prugh et al. 2009, Ritchie and Johnson 2009, Wallach et al 2010, Estes et al. 2011, Miller et al. 2012).

The loss of apex predators from an ecosystem can reduce biodiversity and shorten food web lengths. The loss of apex predators can altering the presence and abundance of mesopredators, can increase the intensity of herbivory, and ultimately can impact the abundance and composition of plant communities, soil structure, nutrients, and even the physical characteristics of the environment (Diamond 1992, Berger et al. 2001, Ripple and Beschta 2006*a*, Ripple and Beschta 2006*b*, Berger et al. 2008, Beschta and Ripple 2008, Prugh et al. 2009, Estes et al. 2011). The presence of native predators in a healthy ecosystem may also improve the ability of the system to resist adverse impacts from invasive species. For example, Wallach et al. (2010) found that increases in dingo populations that occurred in the absence of exclusion fencing and baiting with poison resulted in decreases in mesopredators and generalist herbivores and an increase in small and intermediate-weight mammals.

Most evaluations of the impacts of predator removal or loss on biodiversity involve complete removal of predators over the course of years (*e.g*., see Berger et al. 2001, Beschta and Ripple 2006, Beschta and Ripple 2008, Frank 2008, Gill et al. 2009, Beschta and Ripple 2012*a*). Henke (1992, 1995) documented a decline in species richness and rodent diversity and increases in relative abundance of badgers, bobcats, and gray fox (*Urocyon cinereoargenteus*) in areas of Texas where coyote removal occurred continually throughout the year, which resulted in a sustained 48% reduction in the local coyote population. Cottontail rabbit (*Sylvilagus floridanus*) density and raptor richness, species diversity, and density did not differ between control and treatment areas. However, the continual removal of coyotes throughout the year that occurred by Henke (1992) would not normally occur if the WS program in Oklahoma implemented this alternative. Similarly, the degree of predator removal (exclusion or intensive population reduction efforts via the use of toxicants sustained throughout the year) was far greater in the study by Wallach et al. (2010) than would occur if the WS program implemented this alternative. Based on the findings by Gese (2005), both the number of coyotes and the number of coyote packs in areas with similar activities to those that WS could conduct if the program implemented this alternative had returned to pre-removal levels within 8 months. Although there was evidence of a reduction in the average age of the local coyote population, there was no evidence that this resulted in an increase in coyote densities above pre-removal levels.

WS' actions do not result in long-term extirpation, eradication, or suppression of any native wildlife species, so the findings of most of those studies are not relevant to activities that WS could conduct. The WS program in Oklahoma operates in accordance with federal and State laws and regulations enacted to ensure species viability. If WS implemented this alternative, WS would operate on a relatively small percentage of the land area in Oklahoma and the number of animals from a species that WS could lethally remove would be a small proportion of the total population of any species.

WS does not attempt to eradicate or suppress any species of native wildlife. WS operates in accordance with federal and state laws and regulations enacted to ensure species viability. WS would only use available methods to target individual animals or groups of animals identified as causing damage or posing a threat of damage. Any reduction of a local population or group of animals is frequently temporary because immigration from adjacent areas or reproduction replaces the animals removed. WS would only provide assistance under the appropriate alternatives after receiving a request to manage damage or threats of damage. In addition, WS would only provide assistance on a small percentage of the total land area of Oklahoma. Further, WS would only target those predators identified as causing damage or posing a threat. WS would not attempt to suppress predator populations across broad geographical areas at such intensity levels for prolonged durations that significant ecological effects would occur. The goal of WS would not be to reduce predator populations but to manage damage or threats associated with specific individuals of a species.

Ecosystems are communities of living organisms on, and interacting with, a particular landscape. Ecosystems are dynamic entities that are frequently recovering from periodic disturbances. The frequency and severity of each disturbance determines the way it affects ecosystem function and the ecological services they provide. Animal populations vary from year to year, approaching ecological carrying capacity during resource-rich periods and declining from a lack of resources, overstocking, disease outbreaks, or other mortality sources.

Ecosystem services are the suite of benefits that ecosystems provide to humanity (Cardinale et al. 2012). These services include supporting services, which are processes necessary for the production of all other ecosystem services (*e.g*., nutrient cycling, photosynthesis, and soil formation)(de Groot et al. 2002); provisioning services that involve the production of renewable resources (*e.g*., food, wood, fresh water)(Cardinale et al. 2012); regulating services, which are those that lessen environmental change (*e.g*., climate regulation, pest/disease control)(Cardinale et al. 2012); and cultural services representing human values and enjoyment (*e.g*., landscape aesthetics, cultural heritage, outdoor recreation, and spiritual significance)(Daniel et al. 2012). Biodiversity effects to ecosystem services often receive considerable attention. Consequently, consideration of these ecosystem outputs in management decisions is warranted, and WS is committed to the maintenance of the services provided by the landscapes on which the program works. Given the small number of native predators that WS could remove annually from a given landscape, no loss in ecosystem services is attributable to the program. Since the number of predators that WS could remove annually is a relatively small percentage of overall predator populations, effects to ecosystem resilience are not likely to occur.

As discussed previously, the ODWC is responsible for managing wildlife populations in the State. Therefore, the ODWC would have ability to review any activities conducted by the WS program. Based on this information, the WS program in Oklahoma concludes that potential impacts associated with the implementation of Alternative 1 would not be of sufficient magnitude or scope at the local or state level to adversely affect biodiversity or ecosystem resilience. The WS program in Oklahoma has reviewed the biodiversity plan for Oklahoma and the activities proposed under Alternative 1 would comply with the plan.

POTENTIAL TO CAUSE TROPHIC CASCADES, INCLUDING MESOPREDATOR RELEASE

A trophic cascade is an indirect ecological effect that occurs when the modification of one trophic level occurs to such an extent that it affects other trophic levels in a food chain or web. In a simple example, predators, their herbivore prey, and plants that provide food for the herbivores are three trophic levels that interact in a food chain. A concern that people identify is the potential effects of removing predators on the populations of prey species. For example, people may be concerned that removing coyotes would cause an increase in rodent and rabbit populations, which could result in detrimental effects on vegetation and other resources.

Trophic cascades can also refer to the impact the presence or absence of a larger apex predator has on other predator species that may have different impacts on prey populations (Prugh et al. 2009, Brashares et al. 2010, Miller et al. 2012). Apex predators are large carnivores, such as wolves, bears, large cats. Many apex predator species have experienced dramatic range contractions. Their extirpation from an area is believed to have trophic impacts on the ecosystems in which they occurred, especially through the phenomenon of mesopredator release (Prugh et al. 2009, Miller et al. 2012). Mesopredator release refers to trophic impacts from the absence of apex predators on non-apex predators and ecosystems, which may in turn have different impacts on prey populations than the removed apex predators would have (Prugh et al. 2009, Miller et al. 2012). Normally, competition and intraguild predation (Polis et al. 1989) are thought to control mesopredators in the presence of apex predators and limit their effects on ecosystems.

For example, the presence of coyotes has been shown to limit the density of smaller predators, which may prey more heavily on songbirds, ground nesting birds, and some rodents (Levi and Wilmers 2012, Miller et al. 2012). In addition, carnivores, such as badgers, bobcats, and foxes, have been reported to increase numerically when coyote populations are reduced (Robinson 1961, Nunley 1977, Crookes and Soulé 1999). Recovery of wolves and associated long-term declines in coyotes have also been documented, with the consequence of increased survivorship among pronghorn fawns (Berger and Conner 2008).

The presence of predatory species can cause reductions in the size of a prey population or cause the prey population to alter its use of habitat, which, in turn, can influence plant community composition and health. Depending on the nature of the impact and the prey species, changes in vegetation and prey behavior can have impacts on abiotic factors, such as soil compaction, soil nutrients, and river morphology (Naiman and Rogers 1997, Beschta and Ripple 2006, Beschta and Ripple 2008, Beschta and Ripple 2012*b*). Relationships in trophic cascades are not necessarily a simple linear progression, from predators to prey to vegetation, and can branch through the system. For example, reintroduction of wolves in the Yellowstone ecosystem has been associated with changes in elk density and behavior and reductions in browsing on palatable woody plants, such as aspen (*Populus tremuloides*). Understory shrub species richness and height, including berry-producing plants, were positively correlated with increased height of understory aspen. Increases in berry producing plants have the potential to benefit a wide range of animal species, food availability for omnivores and herbivores, and eventually food availability for other species of predators (Beschta and Ripple 2012*a*). In the Midwest, changes in coyote activity influenced 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.

In general, predators may prolong the low points in rodent population cycles and spread the duration of the population peaks. Predators generally do not control rodent populations (Clark 1972, Wagner and Stoddart 1972, Keith 1974). It is more likely that prey abundance regulates to some degree the populations of predators (Clark 1972, Wagner and Stoddart 1972).

Data on the impacts of coyotes and coyote removal on prey populations are mixed. Wagner (1988) reviewed literature on predator impacts on prey populations and concluded that such impacts vary with the locale. In two studies conducted in south Texas (Beasom 1974, Guthery and Beasom 1977), intensive short-term predator removal was employed to test the response of game species to reduced coyote abundance. At the same time, Beasom (1974) and Guthery and Beasom (1977) monitored rodent and lagomorph species. A marked reduction in coyote numbers apparently had no notable effect on the populations of rabbits or rodents in either study. Similarly, Neff et al. (1985) noted that reducing coyote populations on their study area in Arizona to protect pronghorn antelope fawns had no apparent effect on the rodent or rabbit population. Wagner and Stoddart (1972) noted that coyote predation was a major source of mortality in a black-tailed jackrabbit (*Lepus californicus*) population that may have played an important part in population trends, but they made no connection between predator damage management, jackrabbit mortality, or coyote population size. In fact, any moderating effects from coyotes on jackrabbit densities in the Wagner and Stoddart (1972) study occurred despite activities that were considerably more intensive (aerial shooting, trapping for bounties and pelts, and the use of poison bait stations) than what normally occurs as part of current activities conducted by WS).

In some ecosystems, prey species, such as snowshoe hares, increased to the point that they depleted vegetative food sources despite predation. In others, coyotes may limit jackrabbit density, while food shortages do not limit jackrabbit abundance (Wagner 1988, Stoddart et al. 2001). Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality in the Curlew Valley of Utah, which may have caused a decline in the local jackrabbit population in the Valley. Wagner and Stoddart (1972) made no connections between coyote removal and jackrabbit mortality or coyote populations. The coyote population in the study conducted by Wagner and Stoddart (1972) was subject to more sustained and intensive removal (aerial shooting, trapping for bounties, pelt harvest, and the use poisoned baits that were placed in the fall and recovered in the spring) than would occur if the WS program in Oklahoma implemented this alternative. Any moderating effects of coyotes on jackrabbit populations occurred even though the population was subject to intensive removals. Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote populations and jackrabbit populations in northern Utah and southern Idaho. Both Wagner and Stoddart (1972) and Clark (1972) concluded that coyote populations seemed to respond to an abundance of jackrabbits. Complexity of the system and the range of available prey species may also influence the relationships between predators and prey. When a broad range of prey species are available, coyotes will 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).

Intensive studies of the snowshoe rabbit population cycles by Krebs et al. (2001) reflect the complexity of predator and prey relationships. Krebs et al. (2001) determined a 10-year cycle in snowshoe hares was the result of an interaction between predation and food supplies, with predation playing the principle role in driving the cycle in the hare population. Krebs et al. (2001) found a link between mammalian predator abundance (primarily coyotes and Canada lynx (*Lynx canadensis*)) and the abundance of hares with predator abundance lagging the hare cycle by one to two years. Although Canada lynx and coyotes were key predators influencing hare survival, many species of predators were involved in the cycle, and Krebs et al. (2001) were unable to pinpoint the specific role of any one species of predators. The importance that a range of predators can have on the 10-year cycle of hares occurs on Anticosti Island on the St. Lawrence River in eastern Canada. Canada lynx no longer occur on the island, but the hare cycle persists, likely due to compensatory predation by other species (Keith 1963, Stenseth et al. 1997). Impacts of food in the studies reported by Krebs et al. (2001) appeared to be indirect and were associated with declines in body condition, which may influence chronic stress, the ability of hares to avoid predators, and reproductive output. The study also implicated long-range movement of predators as the potential mechanism behind the synchronicity of the snowshoe hare population cycles over large geographic regions. As indicated previously, the role of predators and food supplies appears to vary. Stevens (2010) provided an example of a system in Sweden in which red fox prey on voles, grouse, and hares. Like the snowshoe hare and lynx example, the fox and prey species appear to have linked population cycles with changes in predator populations following changes in prey populations. However, unlike the snowshoe hare example, forage availability appeared to have a more direct impact on prey populations. Based on forage switching from preferred to less preferred forage, in this system, the availability of forage also acts as a limiting factor on prey populations. When preferred food was scarce, individuals grew more slowly and reproduced less.

Keith (1974) concluded that: 1) during cyclic declines in prey populations, predation has a depressive effect and as a result, the prey populations may decline further and be held 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) since rabbit and rodent populations increase at a faster rate than predator populations, factors other than predation must initiate the decline in populations. Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote and black-tailed jackrabbit populations in northern Utah and southern Idaho. Both Wagner and Stoddart (1972) and Clark (1972) concluded that coyote populations seemed to respond to an abundance of jackrabbits. When a broad range of prey species are available, coyotes will 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).

Rabbit and rodent populations normally fluctuate substantially in several-year cycles. Two hypotheses attempt to explain these cyclic fluctuations. Those two hypotheses maintain that (1) rodent and rabbit populations self-regulate through behavior, changes in reproductive capacity due to stress, or genetic changes (Chitty 1967, Myers and Krebs 1971), or (2) environmental factors regulate populations, such as food and predation (Pitelka 1957, Fuller 1969). Wagner (1988) reviewed literature on predator impacts on prey populations and concluded that such impacts vary with the locale. In some ecosystems, prey species, such as snowshoe hares, increased to the point that that they depleted vegetative food sources, despite predation. In others, coyotes may limit jackrabbit density and evidence indicated food shortages do not occur to limit jackrabbit abundance (Wagner 1988). Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality in the Curlew Valley of Utah, which may have caused a decline in the local jackrabbit population in the Valley.

Henke (1995) reviewed literature concerning coyote-prey interactions and concluded that short-term coyote removal efforts (less than six months per year) typically did not result in population increases of small mammal species. Gese (2005) noted no impact to lagomorph abundance from the removal of coyotes, possibly because the controlled coyote population returned to pre-removal levels within eight months, while Henke (1995) noted that control for nine months or longer could impact rodent, rabbit, and forage abundance. Additionally, Miller et al. (2012) noted a sustained reduction in coyote abundance (and presumably abundances of other mesopredators that might be released by the reduction in coyotes) as a consequence of wolf restoration which possibly was associated with increased abundance of voles within three kilometers of wolf dens.

Some individuals have expressed concerns that activities, such as those activities that WS could conduct when implementing this alternative, would cause disruptions to trophic cascades or irruptions in prey populations by eliminating or substantially reducing top predators (*e.g.*, see Prugh et al. 2009, Ritchie and Johnson 2009, Estes et al. 2011, Bergstrom et al. 2014). The WS program in Oklahoma has reviewed those studies but, for the most part, they are not applicable to the types of activities that WS could conduct if the program implemented this alternative. Those studies involve reviews of the complete absence of apex consumers from the system (*e.g.*, see Berger et al. 2001, Beschta and Ripple 2006, Beschta and Ripple 2008, Frank 2008, Gill et al. 2009, Ripple et al. 2010, Estes et al. 2011, Ripple et al. 2013). In some instances, impacts have also been observed in cases where the predators were substantially reduced over an extended period (*e.g.*, see Henke 1992, Henke 1995, Henke and Bryant 1999, Wallach et al. 2010). Ripple and Beschta (2006*a*) documented a site in Zion National Park largely avoided by cougar because of high human activity, an impact sustained over a period of decades. A reduction in cougars resulted in increases in mule deer and associated increases in herbivory on riparian cottonwoods. Ultimately, this resulted in decreased cottonwood regeneration in the riparian area, increases in bank erosion and reduction in both terrestrial and aquatic species abundance.

If the WS program in Oklahoma implemented this alternative, WS' activities would not result in an elimination of predators. Lethal removal, when necessary, is highly specific to individual damage situations. For example, WS removes only a minor portion of a coyote population during specific times when livestock are most vulnerable to predation, or WS removes individual animals in response to damage that is occurring to property or other resources. Studies show that coyotes are highly prolific and capable of rapid repopulation from areas following localized damage management and from sport (hunter) harvest (Gese 1998, Blejwas et al. 2002, Williams et al. 2003). Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area despite removal of breeding coyotes. Blejwas et al. (2002) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following the removal of the territorial pair. Williams et al. (2003) noted that temporal genetic variation in coyote populations experiencing high turnover (due to removals) indicated that "*...localized removal effort does not negatively impact effective population size...*". While removing coyotes from small areas at the appropriate time can protect vulnerable resources (such as birthing and young livestock), immigration of coyotes from the surrounding area quickly replaces the animals removed and maintains biodiversity (Stoddart 1984). Therefore, there is no evidence that coyote damage management actions would lead to indirect increases in mesopredators (*e.g.,* skunk, raccoon, fox).

Therefore, implementation of this alternative would not result in the extirpation or suppression of any native predator population. The number of animals from a species' population that WS could lethally remove annually under this alternative would be of low magnitude and activities would occur in relatively small or isolated geographical areas. As discussed previously, the ODWC is responsible for managing wildlife populations in the State. Therefore, the ODWC would have ability to review any activities conducted by the WS program. Based on this information, the WS program in Oklahoma concludes that potential impacts associated with the implementation of Alternative 1 would not be of sufficient magnitude or scope at the local or state level to cause trophic cascades or result in mesopredator release.

Alternative 2 – WS Would Address Predator Damage through an Adaptive Integrated Approach Using Only Non-lethal Methods

A non-lethal management alternative would require the WS program to only recommend and use non-lethal methods to manage and prevent damage associated with predators. WS would provide technical assistance and direct operational assistance under this alternative recommending and using only non-lethal methods. Non-lethal methods have the potential to cause adverse effects to non-target animals primarily through exclusion, harassment, and dispersal. Any exclusionary device erected to prevent access of target species also potentially excludes species that are not the primary reason the exclusion was erected; therefore, individual non-target species excluded from areas may potentially be adversely affected if the area excluded was large enough. The use of auditory and visual dispersal methods would also likely disperse non-target animals in the immediate area the methods were employed. Therefore, when employing non-lethal dispersal techniques, non-target animals may disperse permanently from an area. However, like target species, the potential impacts on non-target species would be temporary with target and non-target species often returning after the cessation of dispersal methods.

Live traps (*e.g.*, cage traps, foothold traps) restrain wildlife once captured and are considered live-capture methods. Live traps have the potential to capture non-target species. Trap placement in areas where target species were active and the use of target-specific attractants could minimize the capture of non-target animals. If traps were attended to appropriately, any non-target animals captured could be released on site unharmed.

WS' involvement in the use of or recommendation of non-lethal methods would ensure impacts to non-target animals were considered under WS' Decision Model. Most non-lethal methods would be available under all the alternatives analyzed. Impacts to non-target animals from the use of non-lethal methods would be similar to the use of those non-lethal methods under any of the alternatives. Non-target animals would generally be unharmed from the use of non-lethal methods under any of the alternatives since no lethal removal would occur from their use. Similar to the other alternatives, other entities could and would likely continue to use lethal methods and those activities could increase in proportion to the reduction of assistance using lethal methods provided by the WS program. Risks to non-target animals and T&E species would continue to occur from activities conducted by other entities, including from those people who implement damage management activities on their own similar to Alternative 3 and Alternative 4.

Alternative 3 – Predator Damage Management by WS through Technical Assistance Only

Under a technical assistance only alternative, WS would have no direct impact on non-target species, including T&E species. Those persons requesting assistance could employ methods that WS' personnel recommend or provide through loaning of equipment. Using the WS Decision Model, WS' personnel would base recommendations from information provided by the person requesting assistance or through site visits. Recommendations would include methods or techniques to minimize non-target impacts associated with the methods that personnel recommend or loan. Methods recommended could include non-lethal and lethal methods as deemed appropriate by the WS Decision Model and as permitted by laws and regulations.

The potential impacts to non-targets under this alternative would be variable and based on several factors. If people employed methods as recommended by WS, the potential impacts to non-targets would likely be similar to Alternative 1. If recommended methods and techniques were not followed or if other methods were employed that were not recommended, the potential impacts on non-target species, including T&E species would likely be higher compared to Alternative 1.

The potential impacts of harassment and exclusion methods on non-target species would be similar to those described under Alternative 1 and Alternative 2. Harassment and exclusion methods would be easily obtainable and simple to employ. Since identification of targets would occur when employing shooting as a method, the potential impacts to non-target species would likely be low under this alternative. However, the knowledge and experience of the person could influence their ability to identify coyotes correctly.

Those persons experiencing damage from predators may implement methods and techniques based on the recommendations of WS. The knowledge and skill of those persons implementing recommended methods would determine the potential for impacts to occur. If those persons experiencing damage do not implement methods or techniques correctly, the potential impacts from providing only technical assistance could be greater than Alternative 1. The incorrect implementation of methods or techniques recommended by WS could lead to an increase in non-target removal when compared to the non-target removal that could occur by WS under Alternative 1.

If requesters were provided technical assistance but do not implement any of the recommended actions and conducted no further action, the potential to remove non-targets would be lower when compared to Alternative 1. If those persons requesting assistance implement recommended methods appropriately and as instructed or demonstrated, the potential impacts to non-targets would be similar to Alternative 1. If WS made recommendations on the use of methods to alleviate damage but those methods were not implemented as recommended by WS or if those methods recommended by WS were used inappropriately, the potential for lethal removal of non-targets would likely increase under a technical assistance only alternative. Therefore, the potential impacts to non-targets, including T&E species, would be variable under a technical assistance only alternative.

Under this alternative, if those people requesting assistance from WS deemed recommended non-lethal methods ineffective, those people experiencing damage could employ lethal methods. The potential impacts on non-targets by those persons experiencing damage would be highly variable. People whose predator damage problems were not effectively resolved by non-lethal control methods would likely resort to other means of legal or illegal lethal control. This could result in less experienced people implementing control methods and could lead to greater removal of non-target wildlife than Alternative 1. When those persons experiencing damage caused by wildlife reach a level where assistance does not adequately reduce damage or where no assistance is available, people have resorted to using chemical toxicants that are illegal for use on the intended target species. The illegal use of methods often results in loss of both target and non-target wildlife (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015). The use of illegal toxicants by those persons frustrated with the lack of assistance or assistance that inadequately reduces damage to an acceptable level can often result in the indiscriminate removal of wildlife species.

The ability to reduce negative effects caused by predators to wildlife species and their habitats, including T&E species, would be variable under this alternative. The skills and abilities of the person implementing damage management actions would determine the risks to non-target animals. This alternative would likely have a greater chance of reducing damage than Alternative 4 since WS would be available to provide information and advice on appropriately employing methods and reducing the risk of non-target removal.

Alternative 4 – No Predator Damage Management Conducted by WS

Under this alternative, WS would not provide any assistance with managing damage associated with predators in the State. Therefore, no direct impacts to non-targets or T&E species would occur by WS under this alternative. Risks to non-targets and T&E species would continue to occur from those people who implement damage management activities on their own or through recommendations by other federal, state, and private entities. Although some risks could occur from those people that implement predator damage management in the absence of any involvement by WS, those risks would likely be low, and would be similar to those risks under the other alternatives.

The ability to reduce negative effects caused by predators to other wildlife species and their habitats, including T&E species, would be variable based upon the skills and abilities of the person implementing damage management actions under this alternative.

Issue 3 - Effects of Predator Damage Management Activities on Human Health and Safety

A common concern is the potential adverse effects that methods available could have on human health and safety. Each of the alternatives below evaluates the threats to human safety of methods available under those alternatives.

Alternative 1 - Continue the Current Adaptive Integrated Methods Approach to Managing Predator Damage (No Action/Proposed Action)

The cooperator requesting assistance would be made aware through a MOU, work initiation document, or a similar document that those methods agreed upon could potentially be used on property owned or managed by the cooperator. Therefore, the cooperator would be made aware of the possible use of those methods on property they own or manage to identify any risks to human safety associated with the use of those methods. Cooperators would be made aware by signing a MOU, work initiation document, or another similar document, which would assist WS and the cooperating entity with identifying any risks to human safety associated with methods at a particular location.

Under Alternative 1, WS could use or recommend those methods discussed in Appendix B singularly or in combination to resolve and prevent damage associated with predators in the State. WS would use the Decision Model to determine the appropriate method or methods that would effectively resolve the request for assistance. Those methods would be continually evaluated for effectiveness and if necessary, additional methods could be employed. Non-lethal and lethal methods could be used under this alternative. WS would continue to provide technical assistance and/or direct operational assistance to those persons seeking assistance with managing damage or threats from predators. Risks to human safety from technical assistance conducted by WS would be similar to those risks addressed under Alternative 3. Those non-lethal methods that could be used as part of an integrated approach to managing damage that would be available for use by WS as part of direct operational assistance, would be similar to those risks associated with the use of those methods under the other alternatives.

Lethal methods available under Alternative 1 would include the use of euthanasia chemicals, cable devices, body-grip traps, shooting, fumigants (coyotes, red fox, striped skunks only), sodium cyanide (coyotes, fox, feral dogs only), and the recommendation of harvest during hunting and/or trapping seasons. In addition, target predators live-captured using non-lethal methods (*e.g.*, live-traps, immobilizing drugs) could be euthanized. Those lethal methods available under Alternative 1 or similar products would also be available under the other alternatives. None of the lethal methods available would be restricted to use by WS only, except sodium cyanide (M-44 devices). Euthanasia chemicals would have limited availability to the public but those predators live-captured could be killed using other methods. In addition, other entities could seek to register the use of sodium cyanide (M-44 devices) in the State and the ODAFF could issue permits for aerial operations to remove predators.

WS' employees who conduct activities to manage damage caused by predators would be knowledgeable in the use of those methods available, the wildlife species responsible for causing damage or threats, those

SOPs addressed in this EA, and WS' directives. WS' personnel in Oklahoma would incorporate that knowledge into the decision-making process inherent with the WS Decision Model that employees would apply when addressing threats and damage caused by predators. When employing lethal methods, WS' employees would consider risks to human safety when employing those methods based on location and method. For example, risks to human safety from the use of methods would likely be lower in rural areas that are less densely populated. Personnel would also consider the location where they conduct damage management activities based on property ownership. If WS' personnel employed methods on private property in rural areas where access to the property could be controlled and monitored, the risks to human safety from the use of methods would likely be less. If damage management activities occurred at public parks or near other public use areas, then risks of the public encountering damage management methods and the corresponding risk to human safety would increase. Activities would generally be conducted when human activity was minimal (*e.g.*, early mornings, at night) or in areas where human activities was minimal (*e.g.*, remote rural areas, in areas closed to the public).

The use of live-capture traps, restraining devices (*e.g.*, foothold traps, some cable devices), and body-grip trap have been identified as a potential issue. Live-capture traps available for predators would typically be walk-in style traps where predators enter but are unable to exit. Live-traps, restraining devices, and body-grip traps would typically be set in situations where human activity was minimal to ensure public safety. Those methods rarely cause serious injury and only trigger through direct activation of the device. Therefore, human safety concerns associated with live traps, restraining devices, and body-grip traps used to capture wildlife, including predators, would require direct contact to cause bodily harm. Therefore, if left undisturbed, risks to human safety would be minimal. WS' personnel would prominently post signs for public view at access points warning of the use of those tools in the area to increase awareness that those devices were present and to avoid the area, especially pet owners. In addition, the manager and/or the property owner would be aware that WS was using methods on their property, which provides the manager and/or the property owner the opportunity to alert guests using their property of the presence of methods.

Safety issues related to the misuse of firearms and the potential human hazards associated with the use of firearms were issues identified. To help ensure the safe use of firearms and to increase awareness of those risks, WS' employees who use firearms during official duties would be required to attend an approved firearm safety training course and to remain certified for firearm use must attend a safety training course in accordance with WS Directive 2.615. As a condition of employment, 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)). A safety assessment based on site evaluations, coordination with cooperating and local agencies (if applicable), and consultation with cooperators would be conducted before firearms were deemed appropriate to alleviate or reduce damage and threats to human safety when conducting activities. WS would work closely with cooperators requesting assistance to ensure WS' personnel consider safety issues before deeming firearms appropriate for use. The security of firearms would also occur pursuant to WS Directive 2.615.

The issue of using chemical methods as part of managing damage associated with wildlife relates to the potential for human exposure either through direct contact with the chemical or exposure to the chemical from wildlife that have been exposed. Under the alternatives identified, the use of chemical methods could include immobilizing drugs, euthanasia chemicals, sodium cyanide (M-44 devices) (coyotes, fox, feral dogs only), gas cartridges (coyotes, fox, skunks only), and repellents.

WS' personnel would only administer immobilizing drugs to predators that were live-captured using other methods or they would administer the drugs through injection using a projectile (*e.g.*, dart gun). Personnel could use immobilizing drugs to temporarily sedate animals during handling and while transporting animals to lessen the distress of the animal from the experience. Drug delivery would likely occur on site with close monitoring of the animal to ensure proper care of the animal. Immobilizing drugs would be reversible with a full recovery of sedated animals occurring. Drugs used in capturing and handling wildlife that would be available include ketamine, a mixture of ketamine/Xylazine, and Telazol. Appendix B contains a list and description of immobilizing drugs available for use under the identified alternatives.

If WS immobilized target predators species for sampling or translocation and released, risks could occur to human safety if harvest and consumption occurred. SOPs employed by WS to reduce risks are discussed in Chapter 3 and in Appendix B. SOPs that would be part of the activities conducted include:

- All immobilizing drugs used in capturing and handling animals would be under the direction and authority of state veterinary authorities, either directly or through procedures agreed upon between those authorities and WS.
- As determined on a state-level basis by those veterinary authorities (as allowed by AMDUCA), animal damage management programs may choose to avoid capture and handling activities that utilize immobilizing drugs within a specified number of days prior to the hunting or trapping season for the target species. This practice would avoid release of animals that may be consumed by hunters and/or trappers prior to the end of established withdrawal periods for the particular drugs used. Ear tagging or other marking of animals drugged and released to alert hunters and trappers that they should contact state officials before consuming the animal.
- Most animals administered immobilizing drugs would be released well before hunting/trapping seasons, which would give the drug time to metabolize completely out of the animals' systems before they might be harvested and consumed by people. In some instances, animals collected for control purposes would be euthanized when they were captured within a certain specified time period prior to the legal hunting or trapping season to avoid the chance that they would be consumed as food while still potentially having immobilizing drugs in their systems.

Meeting the requirements of the AMDUCA should prevent any adverse effects to human health with regard to this issue.

WS' personnel in Oklahoma would administer euthanizing chemicals under similar circumstances to immobilizing drugs. Personnel could administer euthanasia chemicals to animals once those animals were live-captured using other methods. Euthanasia chemicals would include sodium pentobarbital, potassium chloride, and Beuthanasia-D. Euthanized animals would be disposed of in accordance with WS Directive 2.515; therefore, would not be available for harvest and consumption. Euthanasia of target animals would occur in the absence of the public to minimize risks, whenever possible.

The recommendation of repellents or the use of those repellents registered for use to disperse animals in the State could occur under Alternative 1 as part of an integrated approach to managing damage. Those chemical repellents that would be available to recommend for use or that could be directly used by WS under this alternative would also likely be available under any of the alternatives. Therefore, risks to human safety from the recommendation of repellents or the direct use of repellents would be similar across all the alternatives. Risks to human safety associated with the use of repellents by WS or the recommendation of repellents by WS is addressed under the technical assistance only alternative (Alternative 3). Risks to human safety would be similar across all the alternatives. WS' involvement, either through recommending the use of repellents or the direct use of repellents, would ensure that label requirements of those repellents were discussed with those persons requesting assistance when recommended through technical assistance or would be specifically adhered to by WS' personnel when using those chemical methods. Therefore, the risks to human safety associated with the recommendation of or direct use of repellents could be lessened through WS' participation.

The EPA (1994) "…*does not anticipate significant environmental exposure to sodium cyanide when used as an encapsulated material together with the M-44 ejector device and when the directions specified on the label are followed*". In addition, the EPA (1994) stated, "*The risk of cyanide poisoning from the current pesticidal uses to workers is minimal because of the current label restrictions*" and the "*…environmental impact of the pesticidal use of sodium cyanide is expected to be minimal because of its mode of application*". Those statements were re-affirmed by the EPA during a recent review of the registration of sodium cyanide in the M-44 device (EPA 2009).

The M-44 device, which contains sodium cyanide, is registered for use in Oklahoma for WS' personnel only. The EPA (1994) concluded that the encapsulated use of sodium cyanide in M-44 devices would pose minimal risks to the environment based on the use pattern and the degradation pattern of sodium cyanide. Sodium cyanide readily reacts with moisture and atmospheric carbon dioxide to produce hydrogen cyanide gas. If a spill occurs or when the ejector is fired, the reaction of the sodium cyanide with moisture and carbon dioxide produces hydrogen cyanide gas that would diffuse into the atmosphere and be diluted into the air (EPA 1994). Reactions with soil components convert sodium cyanide to carbon dioxide and ammonia or other nitrogen containing compounds (EPA 1994). Microorganisms are also known to decompose cyanide in soils by producing carbon dioxide and ammonia as end products. Therefore, the EPA (1994) determined that groundwater contamination by cyanide from M-44 devices was not anticipated. The EPA (1994) also determined that the risk of cyanide poisoning to the users of the M-44 device were mitigated by the label restrictions, the 26 specific use restrictions, and the restricted use classification of sodium cyanide.

To reduce risks to the public, signs warning of the placement of M-44 devices would be posted at property access points and at locations where the devices were deployed. The warning signs help to increase awareness that M-44 devices are deployed and for the public to avoid the area.

Gas cartridges could be available to fumigate burrows and den sites of coyotes, fox, and skunks in areas where damages were occurring. Gas cartridges act as a fumigant by producing carbon monoxide gas when ignited. The cartridges contain sodium nitrate, which when burnt, produces carbon monoxide gas. WS' personnel would place the cartridges inside active burrows and dens at the entrance, ignite the cartridge, and seal the entrance to the burrow or den with dirt, which allows the burrow or den to fill with carbon monoxide. The carbon monoxide would dissipate into the atmosphere and be diluted by the air (EPA 1991). WS' personnel would follow label instructions when employing gas cartridges. Therefore, no risks to human safety would occur from the use of gas cartridges.

The recommendation by WS that some predators be harvested during the regulated hunting and/or trapping season that is established by the ODWC would not increase risks to human safety above those risks already inherent with hunting and/or trapping those predators. Recommendations of allowing hunting and/or trapping on property owned or managed by a cooperator to reduce predator populations, which could then reduce damage or threats, would not increase risks to human safety. Safety requirements established by the ODWC for the hunting and trapping season would further minimize risks associated with those activities. Although hunting and trapping accidents do occur, the recommendation of allowing hunting or trapping to reduce localized populations of predators would not increase those risks.

HUMAN SAFETY CONSEQUENCES OF AERIAL WILDLIFE OPERATIONS ACCIDENTS

Beyond environmental consequences, other issues related to aviation accidents include the loss of aircraft and risks to the public and crewmembers. The use of aircraft by WS would be quite different from general aviation use. The environment in which WS would conduct aerial operations would be inherently a higher risk environment than that for general aviation. Low-level flights introduce hazards, such as power lines and trees, and the safety margin for error during maneuvers is higher compared to high-level flights. In 1998, the WS program commissioned an independent review of its aerial hunting operations because of several accidents. The panel made several recommendations to WS regarding enhanced aerial safety. The WS program implemented most all of those recommendations by 2001. WS has implemented an Aviation Safety Program to support aerial activities and recognizes that an aggressive overall safety and training program is the best way to prevent accidents. While the goal of the aviation program is to have no accidents, accidents may still occur, especially those involving mechanical failure. Pilots and contractors would be highly skilled with commercial pilot ratings that have passed proficiency tests in the flight environment encountered by the WS program. Pilots, gunners, and ground crews would be trained in hazard recognition and shooting would only be conducted in safe environments. Federal aviation regulations require pilots to fly a minimum distance of 500 feet from structures and people, and all employees involved in those operations would adhere to this requirement. Because of the remote locations in which the WS program conducts aerial operations, the risk to the public from aviation operations or accidents would be minimal.

EXECUTIVE ORDERS RELATING TO CHILDREN AND ENVIRONMENTAL JUSTICE

WS would use only legal, effective, and environmentally safe damage management methods, tools, and approaches. The EPA through the FIFRA, the ODAFF, the United States Drug Enforcement Administration, MOUs, annual work plans with land managing agencies, and WS' directives would regulate chemical methods that could be available for use by WS pursuant to the alternatives (see WS Directive 2.401, WS Directive 2.405, WS Directive 2.430, WS Directive 2.465). WS would properly dispose of any excess solid or hazardous waste. WS does not anticipate the alternatives would result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations. In contrast, the alternatives may benefit minority or low-income populations by reducing threats to public health and safety and property damage.

Children may suffer disproportionately for many reasons from environmental health and safety risks, including the development of their physical and mental status. WS makes it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children. WS has considered the impacts that this proposal might have on children. The proposed activities would occur by using only legally available and approved methods where it is highly unlikely that activities conducted pursuant to the alternatives would adversely affect children. For these reasons, WS concludes that it would not create an environmental health or safety risk to children from implementing the alternatives. Additionally, the need for action identified a need to reduce threats to human safety, including risks to children; therefore, cooperators could request WS' assistance with reducing threats to the health and safety of children posed by predators.

No adverse effects to human safety have occurred from WS' use of methods to alleviate predator damage in the State from FY 2009 through FY 2016. The risks to human safety from the use of non-lethal and lethal methods, when used appropriately and by trained personnel, would be considered low. Based on the use patterns of methods available to address damage caused by predators, this alternative would comply with Executive Order 12898 and Executive Order 13045.

Alternative 2 – WS Would Address Predator Damage through an Adaptive Integrated Approach Using Only Non-lethal Methods

A non-lethal management alternative would require the WS program to only recommend and use non-lethal methods to manage and prevent damage caused by predators. WS would provide technical assistance and direct operational assistance under this alternative recommending and using only non-lethal methods. Similar to the other alternatives, other entities could and would likely continue to use lethal methods and those activities could increase in proportion to the reduction of assistance using lethal methods provided by the WS program. Threats to human safety would continue to occur from activities conducted by other entities, including from those people who implement damage management activities on their own similar to Alternative 3 and Alternative 4.

Non-lethal methods recommended or employed by the WS program have the potential to threaten human safety. Threats to human safety associated with non-lethal methods that would be available under this alternative were addressed under Alternative 1. The threats to human safety associated with non-lethal methods under this alternative would be the same as those threats addressed under Alternative 1. The recommendation and use of non-lethal methods by WS would comply with Executive Order 12898 and Executive Order 13045 under this alternative.

Other entities could still provide assistance using lethal methods under this alternative. Those entities would likely continue to employ those lethal methods discussed in Appendix B. If the assistance using lethal methods provided by those entities increased in proportion to assistance that the WS program would have provided using lethal methods, the potential threats to human safety from methods available would be similar to other alternatives. If those entities increase assistance using lethal methods in proportion to the assistance that the WS program would have provided, risks would be similar to Alternative 1. This could result in less experienced persons implementing lethal methods and could lead to greater risks to human safety. Other entities could use lethal methods where the personnel of the WS program may not because WS' personnel would follow those SOPs outlined in Chapter 3 to reduce threats to human safety. Lethal methods employed by those persons not experienced in the use of methods or were not trained in their proper use, could increase threats to human safety. The ODAFF could continue to issue permits to shoot certain predator species from aircraft under this alternative.

Alternative 3 – Predator Damage Management by WS through Technical Assistance Only

Under this alternative, WS would be restricted to making recommendations on the use of methods and the demonstration of methods to resolve damage. WS would only provide technical assistance to those people requesting assistance with damage and threats caused by predators. Although hazards to human safety from non-lethal methods exist, those methods are generally regarded as safe when used by trained individuals who are experienced in their use. Risks to human safety associated with non-chemical methods, such as exclusion, guard animals, limited habitat management, animal husbandry, frightening devices, and cage traps, could be considered low based on their use profile for alleviating damage associated with wildlife. Although some risk of fire and bodily harm exists from the use of pyrotechnics and propane cannons, when used appropriately and in consideration WS could recommend the use of those risks, those methods could be used with a high degree of safety.

Under a technical assistance only alternative, the availability of immobilizing drugs, euthanasia chemicals, and aircraft to those persons experiencing damage or other entities would be limited. Immobilizing drugs and euthanasia chemicals used in capturing and handling wildlife could be administered under the direction and authority of state veterinary authorities, either directly or through procedures agreed upon between those authorities and other entities, such as the ODWC. Without access to immobilizing drugs or euthanizing chemicals, those persons capturing predators using live-traps or other live-capture methods would be responsible for euthanizing or handling live-captured captive animals. Since the availability of immobilizing drugs and euthanizing chemicals would be limited under this alternative, a gunshot would likely be the primary method of euthanasia. The use of aircraft, primarily the use of firearms from an aircraft, would require a permit from the ODWC. Sodium cyanide (M-44 devices) would not be available for use under this alternative since the use of sodium cyanide is currently restricted to use by WS' personnel only in the State. However, if WS was not available to provide direct operational assistance under this alternative, other entities could pursue registering sodium cyanide (M-44 devices) in the State.

The recommendation by WS that predators be harvested during the regulated hunting and/or trapping season, which would be established by the ODWC would not increase risks to human safety above those risks already inherent with hunting and trapping predators. Recommendations of allowing hunting and/or trapping on property owned or managed by a cooperator to reduce local predator populations that could then reduce predator damage or threats would not increase risks to human safety. Safety requirements established by the ODWC for the regulated hunting and trapping season would further minimize risks associated with those activities. Although hunting and trapping accidents do occur, the recommendation of allowing hunting or trapping to reduce localized predator populations would not increase those risks.

The recommendation of shooting with firearms as a method of direct lethal removal could occur under this alternative. Safety issues do arise related to misusing firearms and the potential human hazards associated with firearms use when employed to reduce damage and threats. When used appropriately and with consideration for human safety, risks associated with firearms would be minimal. If firearms were employed inappropriately or without regard to human safety, serious injuries could occur. Under this alternative, recommendations of the use of firearms by WS would include human safety considerations. Since the use of firearms to alleviate predator damage would be available under any of the alternatives and the use of firearms by those persons experiencing predator damage could occur whether WS was consulted or contacted, the risks to human safety from the use of firearms would be similar among all the alternatives.

If non-chemical methods were employed according to recommendations and as demonstrated by WS, the potential risks to human safety would be similar to Alternative 1. If methods were employed without guidance from WS or applied inappropriately, the risks to human safety could increase. The extent of the increased risk would be unknown and variable. Non-chemical methods inherently pose minimal risks to human safety given the design and the extent of the use of those methods.

The cooperator requesting assistance would also be made aware of threats to human safety associated with the use of those methods. SOPs for methods are discussed in Chapter 3 of this EA. Risks to human safety from activities and methods recommended under this alternative would be similar to the other alternatives since the same methods would be available. If misused or applied inappropriately, any of the methods available to alleviate predator damage could threaten human safety. However, when used appropriately, methods available to alleviate damage would not threaten human safety. The recommendation of methods by WS to people requesting assistance and the pattern of use recommended by WS would comply with Executive Order 12898 and Executive Order 13045.

Alternative 4 – No Predator Damage Management Conducted by WS

Under the no involvement by WS alternative, WS would not provide assistance with managing damage associated with predators in the State, including technical assistance. Due to the lack of involvement in managing damage caused by predators, no impacts to human safety would occur directly from WS. This alternative would not prevent those entities experiencing threats or damages associated with predators from conducting damage management activities in the absence of WS' assistance. The direct burden of implementing permitted methods would be placed on those people experiencing damage or would require those people to seek assistance from other entities.

Similar to the technical assistance only alternative, immobilizing drugs, euthanasia chemicals, and the use of aircraft would have limited availability under this alternative to the public. Sodium cyanide (M-44 device) would not be available for use under this alternative since only WS' personnel can currently use those devices. However, in the absence of WS' involvement, other entities could pursue the registration of sodium cyanide in the State. In addition, the ODAFF could issue permits for the operation and use of private aircraft to assist with the management of wildlife damage; therefore, other entities could pursue the use of aircraft. Since most methods available to resolve or prevent predator damage or threats would be available to anyone, the threats to human safety from the use of those methods would be similar between the alternatives. However, methods employed by those persons not experienced in the use of methods or were not trained in their proper use, could increase threats to human safety. Overall, the methods available to the public, when applied correctly and appropriately, would pose minimal risks to human safety.

Issue 4 - Humaneness and Animal Welfare Concerns of Methods

As discussed previously, a common issue often raised is concerns about the humaneness of methods available under the alternatives for resolving predator damage and threats. Discussion of method humaneness for those methods available under the alternatives occurs below.

Alternative 1 - Continue the Current Adaptive Integrated Methods Approach to Managing Predator Damage (No Action/Proposed Action)

Under Alternative 1, WS would integrate methods using the WS Decision Model as part of technical assistance and direct operational assistance. Methods available under Alternative 1 could include non-lethal and lethal methods integrated into direct operational assistance conducted by WS. Under this alternative, WS' personnel would use non-lethal methods that people generally regard as humane. Non-lethal methods that would be available include resource management methods (*e.g.*, limited habitat modification, modification of human behavior), translocation, exclusion devices, frightening devices, cage traps, foothold traps, immobilizing drugs, and repellents.

As discussed previously, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal. People may perceive the humaneness of an action differently. Some individuals believe any use of lethal methods to resolve damage associated with wildlife is inhumane because the resulting fate is the death of the animal. Others believe that certain lethal methods can lead to a humane death. Others believe most non-lethal methods of capturing wildlife to be humane because the animal is generally unharmed and alive. Still others believe that any disruption in the behavior of wildlife is inhumane. With the multitude of attitudes on the meaning of humaneness and the varying perspectives on the most effective way to address damage and threats in a humane manner, agencies are challenged with conducting activities and employing methods that are perceived to be humane while assisting those persons requesting assistance to manage damage and threats associated with wildlife. The goal of WS would be to use methods as humanely as possible to resolve requests for assistance to reduce damage and threats to human safety. WS would continue to evaluate methods and activities to minimize the pain and suffering of methods addressed when attempting to resolve requests for assistance.

Some methods have been stereotyped as "*humane*" or "*inhumane*". However, many "*humane*" methods can be inhumane if not used appropriately. For instance, a cage trap would generally be considered by most members of the public as "*humane*", since the animal would be alive and generally unharmed. Yet, without proper care, live-captured wildlife in a cage trap could be treated inhumanely if not attended to appropriately.

Therefore, the goal would be to address requests for assistance effectively using methods in the most humane way possible that minimizes the stress and pain to the animal. Overall, the use of resource management methods, harassment methods, and exclusion devices would be regarded as humane when used appropriately. Although some concern arises from the use of live-capture methods, the stress of animals is likely temporary.

Although some issues of humaneness could occur from the use of cage traps, foothold traps, translocation, and immobilizing drugs, those methods, when used appropriately and by trained personnel, would not result in the inhumane treatment of wildlife. Concerns from the use of those non-lethal methods would be from injuries to animals while those animals were restrained and from the stress of the animal while being restrained or during the application of the method. Pain and physical restraint can cause stress in animals and the inability of animals to effectively deal with those stressors can lead to distress. Suffering occurs when action is not taken to alleviate conditions that cause pain or distress in animals.

If predators were to be live-captured by WS, WS' personnel would be present on-site during capture events or capture devices would be checked frequently to ensure predators captured were addressed in a timely manner and to prevent injury. Although stress could occur from being restrained, timely attention to live-captured wildlife would alleviate suffering. Stress would likely be temporary.

Under Alternative 1, lethal methods could also be employed to alleviate or prevent predator damage and threats, when requested. Lethal methods would include shooting, body-gripping traps, cable devices, euthanasia chemicals, fumigants (coyotes, red fox, striped skunks only), sodium cyanide (coyotes, fox, feral dogs only), and the recommendation of harvest during the hunting and/or trapping season. In addition, predators that are live-captured using non-lethal methods could be euthanized by WS. WS' use of lethal control methods under Alternative 1 would follow those required by WS' directives (see WS Directive 2.505, WS Directive 2.430).

The euthanasia methods being considered for use under Alternative 1 for live-captured predators are carbon dioxide, carbon monoxide, gunshot, and barbiturates or potassium chloride in conjunction with general anesthesia. Those methods are considered acceptable methods by the AVMA for euthanasia and the use of those methods would meet the definition of euthanasia (AVMA 2013). The use of carbon dioxide, carbon monoxide, barbiturates, and potassium chloride for euthanasia would occur after the animal had been live-captured and would occur away from public view. Although the AVMA guideline also lists gunshot as a conditionally acceptable method of euthanasia for free-ranging wildlife, there is greater potential the method may not consistently produce a humane death (AVMA 2013). WS' personnel that employ firearms to address predator damage or threats to human safety would be trained in the proper placement of shots to ensure a timely and quick death.

Research and development by WS has improved the selectivity and humaneness of management techniques. Research is continuing to bring new findings and products into practical use. Until new findings and products were found practical, a certain amount of animal suffering could occur when some methods were used in situations where non-lethal damage management methods were not practical or effective. As stated previously, research suggests that some methods, such as restraint in foothold traps or changes in the blood chemistry of trapped animals, indicate "*stress*" (Kreeger et al. 1990). However, such research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991, Sharp and Saunders 2008, Sharp and Saunders 2011).

Personnel from WS would be experienced and professional in their use of management methods (see WS Directive 1.301). Consequently, management methods would be implemented in the most humane manner possible. Many of the methods discussed in Appendix B to alleviate predator damage and/or threats in the State could be used under any of the alternatives by those persons experiencing damage regardless of WS' direct involvement. Most of the methods discussed in Appendix B to alleviate predator damage and/or threats could be used under any of the alternatives by those persons experiencing damage or their agents regardless of involvement by WS. Therefore, the issue of humaneness associated with methods would be similar across any of the alternatives since those methods could be employed by other entities in the absence of WS' involvement. Those persons who view a particular method as humane or inhumane would likely continue to view those methods as humane or inhumane under any of the alternatives. SOPs that would be incorporated into WS' activities to ensure methods were used by WS as humanely as possible are listed in Chapter 3.

Alternative 2 – WS Would Address Predator Damage through an Adaptive Integrated Approach Using Only Non-lethal Methods

Under this alternative, the WS program would only use non-lethal methods, which most people would generally regard as humane. Non-lethal methods would include resource management methods (*e.g.*, minor habitat modification, modification of human behavior), translocation, exclusion devices, frightening devices, live traps, foothold traps, cable devices, and repellents.

Although some issues of humaneness could occur from the use of non-lethal methods, those methods, when used appropriately and by trained personnel, would not result in the inhumane treatment of predators. Concerns from the use of those non-lethal methods would be from injuries to animals while restrained, from the stress of the animal while being restrained, or during the application of the method. Pain and physical restraint can cause stress in animals and the inability of animals to effectively deal with those stressors can lead to distress. Suffering occurs when people do not take action to alleviate conditions that cause pain or distress in animals.

Overall, many people would regard the use of resource management methods, harassment methods, live-capture methods, and exclusion devices as humane when used appropriately. Although some concern arises from the use of live-capture methods, the stress of animals would likely be temporary and would cease once a person released the animal. Similar to the other alternatives, other entities could continue to use lethal methods under this alternative.

Alternative 3 – Predator Damage Management by WS through Technical Assistance Only

The issue of method humaneness under this alternative would be similar to the humaneness issues discussed under Alternative 1. This similarity would be derived from WS' recommendation of methods that some people may consider inhumane. WS would not directly be involved with damage management activities under this alternative. However, the recommendation of the use of methods would likely result in the requester employing those methods. Therefore, by recommending methods and thus a requester employing those methods, the issue of humaneness would be similar to Alternative 1. Under Alternative 3, WS would recommend the use of euthanasia methods pursuant to WS Directive 2.505. However, the person requesting assistance would determine what methods to use to euthanize or kill a live-captured animal under Alternative 3.

WS would instruct and demonstrate the proper use and placement of methodologies to increase effectiveness in capturing target predators and to ensure methods were used in such a way as to minimize pain and suffering. However, the efficacy of methods employed by a cooperator would be based on the skill and knowledge of the requester in resolving the threat to safety or damage situation despite WS' demonstration. Therefore, a lack of understanding of the behavior of predators or improperly identifying the damage caused by predators along with inadequate knowledge and skill in using methodologies to resolve the damage or threat could lead to incidents with a greater probability of being perceived as inhumane. In those situations, the potential for pain and suffering would likely be regarded as greater than discussed in Alternative 1.

Alternative 4 – No Predator Damage Management Conducted by WS

Under this alternative, WS would not be involved with any aspect of predator damage management in Oklahoma. Those people experiencing damage or threats associated with predators could continue to use those methods legally available. Those persons who would consider methods to be inhumane would likely consider those methods to be inhumane under any alternative. The issue of humaneness would likely be directly linked to the methods legally available to the public since methods are often labeled as inhumane by segments of society no matter the entity employing those methods.

The humaneness of methods would be based on the skill and knowledge of the person employing those methods. A lack of understanding regarding the behavior of predators or methods used could lead to an increase in situations perceived as being inhumane to wildlife despite the method used. Despite the lack of involvement by WS under this alternative, those methods perceived as inhumane by certain individuals and groups would still be available to the public to use to resolve damage and threats caused by predators. Those persons employing methods to live-capture predators would determine when and how to euthanize or kill those animals.

4.3 CUMULATIVE IMPACTS OF ALTERNATIVE 1 BY ISSUE

WS follows CEQ regulations implementing the NEPA (40 CFR 1500 et seq.), USDA (7 CFR 1b), and APHIS Implementing Guidelines (7 CFR 372) as part of the decision-making process. Cumulative impacts, as defined by the CEQ (40 CFR 1508.7), are impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time.

Under Alternative 1, Alternative 2, and Alternative 3, the WS program would address damage associated with predators either by providing technical assistance only (Alternative 3) or by providing technical assistance and direct operational assistance (Alternative 1, Alternative 2) across the State. The WS program would be the primary federal agency conducting direct operational predator damage management in the State under Alternative 1, Alternative 2, and Alternative 3. However, other federal, state, and private entities could also be conducting predator damage management in the State.

WS does not normally conduct direct damage management activities concurrently with other agencies or other entities in the same area, but may conduct damage management activities at adjacent sites within the same period. In addition, commercial companies may conduct damage management activities in the same area. The potential cumulative impacts could occur from either damage management activities over time by WS or from the aggregate effects of those activities combined with the activities of other agencies and private entities. Damage management activities in the State would be monitored by WS to evaluate and analyze activities to ensure they were within the scope of analysis of this EA.

Issue 1 - Effects of Damage Management Activities on Target Predator Populations

The issue of the effects on the statewide predator population arises from the use of non-lethal and lethal methods to address the need for reducing damage and threats. As part of an integrated methods approach to managing damage and threats, WS could apply both lethal and non-lethal methods when requested by those persons experiencing damage.

Non-lethal methods could disperse or otherwise make an area unattractive to predators causing damage; thereby, reducing the presence of predators at the site and potentially the immediate area around the site where non-lethal methods were employed. WS' employees would give non-lethal methods priority when addressing requests for assistance (see WS Directive 2.101). However, WS would not necessarily employ non-lethal methods to resolve every request for assistance if deemed inappropriate by WS' personnel using the WS Decision Model. For example, if a cooperator requesting assistance, had already attempted to disperse predators using non-lethal harassment methods, WS would not necessarily employ those methods again during direct operational assistance since those methods had already been proven to be ineffective in that particular situation. WS and other entities could use non-lethal methods to exclude, harass, and disperse target wildlife from areas where damage or threats were occurring. When effective, non-lethal methods would disperse predators from an area resulting in a reduction in the presence of those predators at the site where WS or another entity employed those methods. However, predators responsible for causing damage or threats would likely disperse to other areas with minimal impacts occurring to predator populations. WS would not employ non-lethal methods over large geographical areas or apply those methods at such intensity that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope that long-term adverse effects would occur to a species' population. WS and most people generally regard non-lethal methods as having minimal impacts on overall populations of wildlife since individuals of those species would be unharmed. Therefore, the use of non-lethal methods would not have cumulative effects on predator populations in the State.

WS' employees could employ lethal methods to resolve damage associated with predators that WS identifies as responsible for causing damage or threats to human safety. However, lethal removal by WS would only occur after receiving a request for such assistance. Therefore, the use of lethal methods could result in local reductions in the number of target animals in the area where damage or threats were occurring since WS would remove those target individuals from the population. WS would often employ lethal methods to reinforce non-lethal methods and to remove predators that have been identified as causing damage or posing a threat to human safety. The use of lethal methods could therefore result in local reductions of predators in the area where damage or threats were occurring. The number of predators removed from the predator population using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of predators involved with the associated damage or threat, and the efficacy of methods employed.

WS would maintain ongoing contact with the ODWC to ensure activities were within management objectives for wildlife. WS would submit annual activity reports to the ODWC. The ODWC would have the opportunity to monitor the total removal of predators from all sources and could factor in survival rates from predation, disease, and other mortality data.

WS and the ODAFF would monitor removal by comparing the number of predators killed with overall populations or trends in populations to assure the magnitude of removal was below the level that would cause undesired adverse effects to the viability of native species populations. This EA analyzed the potential cumulative impacts on the predator population from the implementation of Alternative 1 in Section 4.2.

Evaluation of activities relative to target species indicated that program activities would likely have no cumulative adverse effects on predator populations when targeting those individual animals responsible for damage at the levels addressed in this EA. WS' actions would be occurring simultaneously, over time, with other natural processes and human generated changes that are currently taking place. These activities include, but would not be limited to:

- Natural mortality of predators
- Mortality through vehicle strikes, aircraft strikes, and illegal harvest
- Human-induced mortality from annual hunting and/or trapping seasons for predator species

- Human-induced mortality of predators through private damage management activities
- Human and naturally induced alterations of wildlife habitat
- Annual and perennial cycles in animal population densities

All those factors play a role in the dynamics of predator populations. In many circumstances, requests for assistance arise when some or all of those elements have contrived to elevate target species populations or place target species at a juncture to cause damage to resources. The actions taken to minimize or eliminate damage would be constrained as to scope, duration, and intensity for the purpose of minimizing or avoiding impacts to the environment. WS' personnel would use the Decision Model to evaluate the damage occurring, including other affected elements and the dynamics of the damaging species, to determine appropriate strategies to minimize effects on environmental elements. The Model would allow WS' personnel to implement damage management actions and to monitor those actions to adjust/cease damage management actions, which would allow WS to take into consideration other influences in the environment, such as those listed above, in order to avoid cumulative effects on target species (Slate et al. 1992).

With management authority over predator populations in the State, the ODWC could adjust removal levels, including the removal of WS, to ensure population objectives for predators were achieved. Consultation and reporting of removal by WS would ensure the ODWC had the opportunity to consider any activities WS conducts.

WS' removal of predators in Oklahoma from FY 2009 through FY 2016 was of a low magnitude when compared to the statewide population of those species. The ODWC could consider all known removal when determining population objectives for predators and could adjust the number of individuals from a species that could be harvested during the regulated harvest season and the number of predators removed for damage management purposes to achieve the population objectives. Any removal by WS would occur at the discretion of the ODWC. Therefore, the cumulative removal of predators annually or over time by WS would occur at the desire of the ODWC as part of management objectives for predators in Oklahoma. No cumulative adverse effects on target and non-target wildlife would be expected from WS' damage management activities based on the following considerations:

Historical Outcomes of WS' Damage Management Activities on Animal Populations

WS would conduct damage management activities associated with predators only at the request of a cooperator to reduce damage that was occurring or to prevent damage from occurring and only after methods to be used were agreed upon by all parties involved. WS would monitor activities to ensure any potential impacts were identified and addressed. WS would work closely with resource agencies to ensure damage management activities would not adversely affect predator populations and that WS' activities were considered as part of management goals established by those agencies. Historically, WS' activities to manage damage caused by predators in Oklahoma have not reached a magnitude that would cause adverse effects to those species' populations in the State.

SOPs Built into the WS Program

SOPs are designed to reduce the potential negative effects of WS' actions on predators, and have been tailored to respond to changes in wildlife populations that could result from unforeseen environmental changes (see Section 3.3, Section 3.4). This would include those changes occurring from sources other than WS. Alteration of activities would be defined through SOPs, and implementation would be insured through monitoring, in accordance with the WS Decision Model (see WS Directive 2.201; Slate et al. 1992) and close coordination with ODWC.

Issue 2 - Effects of Predator Damage Management Activities on the Populations of Non-target Wildlife Species, Including T&E Species

Potential effects on non-target species from conducting activities arise from the use of non-lethal and lethal methods to alleviate or prevent damages. The use of non-lethal methods has the potential to exclude, disperse, or capture non-target animals. However, the effects of non-lethal methods are often temporary and often do not involve the removal of non-target animals. When using exclusion devices and/or repellents, both target and non-target wildlife can be prevented from accessing the resource being damaged. Since exclusion and repellents do not involve lethal removal, cumulative impacts on non-target species from the use of exclusionary methods or repellents would not occur but would likely disperse those individuals to other areas. Exclusionary methods and repellents can require constant maintenance to ensure effectiveness. Therefore, the use of some exclusionary devices and repellents would be somewhat limited to small, high-value areas and not used to the extent that non-targets would be excluded from large areas that would cumulatively impact populations from the inability to access a resource, such as potential food sources or denning sites. The use of visual and auditory harassment and dispersion methods would generally be temporary with non-target species returning after the cessation of those activities. Dispersal and harassment do not involve the removal (killing) of non-target species and similar to exclusionary methods would not be used to the extent or at a constant level that would prevent non-targets from accessing critical resources that would threaten survival of a population.

The use of lethal methods or those methods used to live-capture target species followed by euthanasia also have the potential to affect non-target animals through the removal (killing) or capture of non-target species. Capture methods used are often methods that would be set to confine or restrain target animals after being triggered by a target individual. Capture methods would be employed in such a manner as to minimize the threat to non-target species by placement in those areas frequently used by target wildlife, using baits or lures that were as species specific as possible, and modification of individual methods to exclude non-targets from capture. Most methods described in Appendix B are methods that would be employed to confine or restrain wildlife that would be subsequently euthanized using humane methods. With all live-capture devices, non-target wildlife captured could be released on site if determined to be able to survive following release. SOPs are intended to ensure removal of non-target animals was minimal during the use of methods to capture target animals.

The use of firearms and euthanasia methods would essentially be selective for target species since identification of an individual would be made prior to the application of the method. Euthanasia methods would be applied through direct application to target wildlife. Therefore, the use of those methods would not affect non-target species.

All chemical methods would be tracked and recorded to ensure the proper accounting of used and unused chemicals (see WS Directive 2.465). All chemicals would be stored and transported according with WS' Directives and relevant federal, state, and local regulations. Chemical methods available for use under Alternative 1 would include immobilizing drugs, euthanasia chemicals, sodium cyanide (coyotes, fox, feral dogs only), gas cartridges (coyotes, fox, skunks only), and repellents, which are described in Appendix B. Immobilizing drugs and euthanasia chemicals would be applied directly to target animals; therefore, risks to non-targets would be minimal. Repellents would be applied directly to the affected resources with the intent of dispersing animals or discouraging animals from feeding on the resources. Although repellents could disperse or discourage non-target animals, no adverse effects to those species populations would occur. M-44 devices use baits/lures that are highly attractive to target species to minimize risks to non-targets. Gas cartridges would only be used in burrow/den sites of target animals that were active. Chemical methods would generally be placed in areas where exposure to non-targets would be minimal. All chemicals would be used according to product labels, which would ensure that proper use would minimize non-target threats. WS' adherence to Directives and SOPs governing the use of chemicals would also ensure non-target hazards would be minimal.

The methods described in Appendix B have a high level of selectivity and could be employed using SOPs to ensure minimal impacts to non-target species. The unintentional removal of animals would likely be limited and would not reach a magnitude where adverse effects would occur. In addition, some of the species lethally removed by WS as unintentional non-target animals can be harvested during annual hunting and/or trapping seasons. Based on the methods available to resolve predator damage and/or threats, WS does not anticipate the number of non-target animals lethally removed to reach a magnitude where declines in those species' populations would occur. Therefore, removal of non-target animals would not cumulatively affect non-target species.

Concerns have been expressed that WS' activities disrupt trophic cascades or cause mesopredator release by eliminating or substantially reducing top predators (Bergstrom et al. 2014). WS has reviewed those concerns relative to the implementation of the alternatives. WS only conducts activities when and where those activities are permitted, needed, and requested by other entities. When providing assistance, WS' personnel focus on dispersing, capturing, or removing specific animals or local group of animals that are causing damage or posing a threat of damage. WS does not strive to eliminate or remove native predators from any area on a long-term basis. Consequently, no predators or prey would be extirpated and none would be introduced into an ecosystem. Any dispersal or removal of animals would generally be temporary and would occur in relatively small or isolated geographic areas when compared with the overall population of a species. Therefore, WS concludes that implementation of the alternatives would not cause significant negative ecological impacts with respect to apex predators, biodiversity, ecosystem resilience, ecosystem services, mesopredator release, or trophic cascades.

WS has reviewed and would continue to review the list of species in Oklahoma on the Federal List of Endangered and Threatened Wildlife. As appropriate, the WS program in Oklahoma would consult with the USFWS pursuant to Section 7 of the ESA when WS determines activities may affect a threatened or endangered species. Based on the proposed activities, the WS program in Oklahoma and the ODAFF have determined those activities would have no effect on the status of any threatened and endangered species in the State. No take by the WS program in Oklahoma or the ODAFF has occurred previously during activities associated with managing damage caused by predators.

Issue 3 - Effects of Predator Damage Management Activities on Human Health and Safety

Non-chemical methods described in Appendix B would be used within a limited period, would not be residual, and do not possess properties capable of inducing cumulative effects on human health and safety. WS' personnel would use non-chemical methods after careful consideration of the safety of those persons employing methods and to the public. When possible, WS' personnel would use capture methods where human activity was minimal to ensure the safety of the public. Capture methods also require direct contact to trigger, which ensures that those methods, when left undisturbed, would have no effect on human safety. WS' personnel would only use methods the requester agreed to when signing a MOU, work initiation document, or another comparable document. Therefore, WS' personnel would make those entities requesting assistance aware of the safety issues of those methods when entering into a MOU, work initiation document, or another comparable document. SOPs would also ensure the safety of the public from those methods used to capture or remove wildlife. WS' personnel would use firearms in situations that ensure the safety of employees and the public.

Personnel employing non-chemical methods would continue to receive training to be proficient in the use of those methods to ensure the safety of the applicator and to the public. Based on the use patterns of non-chemical methods, those methods would not cumulatively affect human safety.

Repellents to disperse predators from areas of application would be available. Repellents must be registered with the EPA according to the FIFRA and with the ODAFF. Many of the repellents currently available for use have active ingredients that are naturally occurring and are generally regarded as safe. Although some hazards exist from the use of repellents, hazards occur primarily to the handler and applicator. When repellents were applied according to label requirements, no effects to human safety would be expected. Similarly, fumigants must also be registered for use with the EPA and the ODAFF. Given the use patterns of repellents and fumigants, no cumulative effects would occur to human safety.

The WS program in Oklahoma has received no reports or documented any effects to human safety from damage management activities conducted from FY 2009 through FY 2016. WS and the ODAFF do not expect any cumulative effects from the use of those methods discussed in Appendix B given the use patterns of those methods for resolving predator damage in the State.

Issue 4 - Humaneness and Animal Welfare Concerns of Methods

WS would continue to seek new methods and ways to improve current technology to improve the humaneness of methods used to manage damage caused by wildlife. Cooperation with individuals and organizations involved in animal welfare continues to be an agency priority for the purpose of evaluating strategies and defining research aimed at developing humane methods.

All methods not requiring direct supervision during employment (*e.g.*, live traps) would be checked in accordance with Oklahoma laws and regulations to ensure any wildlife confined or restrained were addressed in a timely manner to minimize distress of the animal. WS' personnel would apply euthanasia methods according to WS' directives. Shooting would occur in some situations and WS' personnel would receive training in the proper use of firearms to minimize pain and suffering of predators removed by this method.

WS would employ methods as humanely as possible by applying SOPs to minimize pain. In addition, WS' personnel would address animals live-captured in a timely manner to minimize distress. Through the establishment of SOPs that guide WS in the use of methods, the cumulative impacts on the issue of method humaneness would be minimal. WS would continually evaluate methods to ensure SOPs were adequate and that WS' personnel address live-captured animals in a timely manner to minimize distress.

CHAPTER 5: RESPONSES TO PUBLIC COMMENTS

5.1 SUMMARY OF PUBLIC COMMENTS AND WS' RESPONSES TO THE COMMENTS

WS made the EA available to the public for review and comment through notices published in local media and through direct notification of interested parties. WS made the EA available to the public for review and comment by a legal notice published in *The Daily Oklahoman* newspaper from November 15, 2016 through November 17, 2016. WS also made the EA available to the public for review and comment on the APHIS website on November 7, 2016 and on the regulations.gov website beginning on November 4, 2016. WS also sent a notice of availability directly to agencies, organizations, and individuals with probable interest in managing predator damage in the State. The public involvement process ended on December 16, 2016. During the public comment period, WS received one comment response on the draft EA. Chapter 5 summarizes the comment response received and provides WS' response to the comment.

Comment – The activities of WS are contrary to the desires of the American taxpaying public

Response: People in Oklahoma have requested assistance from WS previously and continue to request assistance from WS. WS only provides assistance after receiving a request for such assistance. Therefore, the need for action to manage damage and threats associated with predators in Oklahoma arises from requests for assistance received by WS (see Section 1.2 of the EA). WS receives requests to reduce or prevent damage from occurring to agricultural resources, natural resources, property, and threats to human safety. WS has identified those predator species most likely to be responsible for causing damage in the State based on previous requests for assistance. Section 1.5 of the EA discusses the authority of the WS program to manage damage caused by animals when requested.

Comment – WS sneaks into areas with no notice to anyone

Response: The WS program only provides assistance after receiving a request for such assistance and only after the entity requesting assistance and WS sign a Memorandum of Understanding, work initiation document, or another similar document. Therefore, the decision-maker for what activities WS conducts is the entity that owns or manages the affected property. The decision-makers have the discretion to involve others as to what occurs or does not occur on property they own or manage. Therefore, in the case of an individual property owner or manager, the involvement of others and to what degree others were involved in the decision-making process would be a decision made by that individual. Section 3.1 in the EA discusses the decision-making process associated with communities, private property owners, and public property managers.

Comment – WS only uses lethal methods and wants to kill all wildlife

Response: The WS Decision Model would be the implementing mechanism for a damage management program under applicable alternatives that personnel adapt to an individual damage situation. When WS receives a request for direct operational assistance, WS would conduct site visits to assess the damage or threats, would identify the cause of the damage, and would apply the Decision Model described by Slate et al. (1992) and WS Directive 2.201 to determine the appropriate methods to resolve or prevent damage. Discussion of the Decision Model and WS' use of the Model occurs in Section 3.1 of the EA. In addition, WS would give preference to non-lethal methods when practical and effective (see WS Directive 2.101). Appendix B in the EA discusses many non-lethal methods that WS' personnel could recommend or employ to resolve damage under the applicable alternatives. The WS program does not attempt to eradicate any species of native wildlife in the State. WS operates in accordance with federal and state laws and regulations enacted to ensure species viability.

Comment – WS uses lethal methods just for the money

Response: As discussed in the EA, funding for WS' activities could occur from federal appropriations, through state funding, and through cooperative funding. Funding for WS' activities could occur through cooperative service agreements with individual property owners or managers. Federal, state, and local officials have made the decision to provide funding for damage management activities and have allocated funds for such activities. Additionally, damage management activities are an appropriate sphere of activity for government programs, since managing wildlife is a government responsibility.

Comment – Funding for the WS program should be cut to zero

Response: Damage management activities are an appropriate sphere of activity for government programs, since managing wildlife is a government responsibility. Eliminating the WS program would be similar to the alternative analyzed in detail in the EA where there would be no involvement by the WS program with any aspect of managing predator damage in Oklahoma (see Alternative 4). Therefore, adding an analysis of an additional alternative whereby WS or another entity pursued the termination of the funding for WS would not add to the existing analyses in the EA. Under Alternative 4, the WS program would not provide assistance with any aspect of managing mammal damage; however, other entities could conduct damage management activities in the absence of the WS program.

Comment – Agriculture producers have a duty to put up fences, use guard animals, electric fences, and other non-lethal methods.

Response: Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. For example, some livestock producers already use non-lethal methods to reduce predation (NASS 2000, NASS 2001, NASS 2005, NASS 2006, NASS 2011, APHIS Veterinary Services 2008, APHIS Veterinary Services 2012, APHIS Veterinary Services 2015, APHIS Veterinary Services 2017). The NASS (2005) and the APHIS Veterinary Services (2015) reported that Oklahoma sheep producers used non-lethal methods to reduce predator damage, such as night penning, guard dogs, llamas, fencing, other nonlethal methods, donkeys, frequent checks, lamb shed, culling, frightening tactics, bedding change, carrion removal, and herding to reduce predation. The NASS (2011) also reported that Oklahoma cattle producers used guard animals, culling, frequent checks, carcass removal, exclusion fencing, fright tactics, herding, night penning, and other non-lethal methods to reduce predation.

However, Andelt (1992) reported that about a third of sheep producers using guard dogs indicated that the use of dogs did not reduce their reliance on other predator control techniques or on predator control agencies. The use of fencing can be effective at excluding predators; however, many of the target predator species are cable of digging under fencing or are able to exploit areas when natural events cause damage to fences (*e.g.*, high water may frequently wash out fences that transverse across streams and creeks, trees or tree branches may fall on fences). Livestock producers often incur indirect costs associated with livestock predation in addition to the direct loss from animals killed by predators, such as the implementation of methods to reduce predation rates (Jahnke et al. 1987). Economic losses associated with predation on livestock often occur despite efforts by livestock producers to reduce predation rates. Many of those non-lethal methods (*e.g.*, fencing, guard animals) require a large investment in time to implement and have a high initial cost (Mitchell et al. 2004). Even with the additional effort and costs, those methods are not always effective at reducing damage and potentially have side effects (*e.g.*, concentrating livestock can cause unwanted damage to particular pasture areas) (Knowlton et al. 1999).

Comment - The killing animals amounts to a government subsidy of business costs for agriculture producers.

Response: As discussed in Section 1.5 of the EA, the WS program is authorized to protect agriculture and other resources from damage caused by wildlife through the Act of March 2, 1931 (46 Stat. 1468; 7 USC 8351-8352) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 8353). In addition, the United States Congress continues to appropriate money to WS for the management of wildlife damage to agricultural resources. Changing the agricultural practices that people conduct is not within the authority of the WS program; therefore, is outside the scope of the EA.

Comment - Stop killing animals because agricultural producers do not want to spend money for non-lethal methods.

Response: Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. For example, some livestock producers already use non-lethal methods to reduce predation (NASS 2000, NASS 2001, NASS 2005, NASS 2006, NASS 2011, APHIS Veterinary Services 2008, APHIS Veterinary Services 2012, APHIS Veterinary Services 2015, APHIS Veterinary Services 2017). The NASS (2005) and the APHIS Veterinary Services (2015) reported that Oklahoma sheep producers used non-lethal methods to reduce predator damage, such as night penning, guard dogs, llamas, fencing, other nonlethal methods, donkeys, frequent checks, lamb shed, culling, frightening tactics, bedding change, carrion removal, and herding to reduce predation. The NASS (2011) also reported that Oklahoma cattle producers used guard animals, culling, frequent checks, carcass removal, exclusion fencing, fright tactics, herding, night penning, and other non-lethal methods to reduce predation.

Therefore, an entity requesting assistance may have already attempted to alleviate damage using non-lethal methods and the WS program would not necessarily employ those same non-lethal methods for that request because the prior use of those methods were ineffective at reducing damage or threats to an acceptable level to the requester. As stated throughout the EA, the WS program would give preference to non-lethal methods where practical and effective under the alternatives in accordance with WS Directive 2.101. However, few non-lethal methods available to alleviate damage or threats associated with predators, such as livestock management practices (*e.g.*, night-penning, herding, carcass removal) and physical exclusion (*e.g.*, predator-proof fencing), are practical for implementation by WS' personnel. The resource owner is responsible for the implementation of most non-lethal methods (Knowlton et al. 1999). In many cases, livestock producers are already employing non-lethal methods to alleviate or prevent damage.

CHAPTER 6: LIST OF PREPARERS AND AGENCIES CONSULTED

6.1 LIST OF PREPARERS

Ryan Wimberly, USDA/APHIS/WS, Environmental Management Coordinator, Tennessee
Kevin Grant, USDA/APHIS/WS, State Director, Oklahoma (retired)
Scott Alls, USDA/APHIS/WS, Assistant State Director, Oklahoma
Patrick Whitley, USDA/APHIS/WS, Wildlife Disease Biologist, Oklahoma

6.2 LIST OF AGENCIES CONSULTED

Oklahoma Department of Wildlife Conservation
United States Fish and Wildlife Service

APPENDIX A
LITERATURE CITED

Air National Guard. 1997. Final environmental impact statement for the Colorado Airspace Initiative, Vol. 1. Impact Analyses. National Guard Bureau, Andrews Air Force Base, Maryland.

Allardyce, D., and M. A Sovada. 2003. A review of the ecology, distribution, and status of swift foxes in the United States. Pages 3-18 in The swift fox: ecology and conservation of swift foxes in a changing world. M.A. Sovada and L. Carbyn, eds. Univ. of Regina; Regina Saskatchewan, Canada.

Allen, G. T., J. K. Veatch, R. K. Stroud, C. G. Vendel, R. H. Poppenga, L. Thompson, J. Shafer, and W. E. Braselton. 1996. Winter poisoning of coyotes and raptors with Furadan-laced carcass baits. Journal of Wildlife Diseases 32:385-389.

Allen, S. H., J. O. Hastings, and S. C. Kohn. 1987. Composition and stability of coyote families and territories in North Dakota. Prairie Nat. 19:107-114.

AVMA. 2004. Animal welfare forum: management of abandoned and feral cats. Journal of the American Veterinary Medical Association. Vol. 225, No. 9, November 1, 2004.

AVMA. 2013. AVMA guidelines on euthanasia. American Veterinary Medical Association. 102 pages.

AVMA. 2014. Free-roaming abandoned and feral cats. https://www.avma.org/KB/Policies/Pages/Free-roaming-Abandoned-and-Feral-Cats.aspx. Accessed November 13, 2014.

Ames, D. R., and L. A. Arehart. 1972. Physiological response of lambs to auditory stimuli. Journal of Animal Science 34:997-998.

Andelt, W. F. 1992. Effectiveness of livestock guarding dogs for reducing predation on domestic sheep. Wildlife Society Bulletin 20:55-62.

Andelt, W. F. 2004. Use of livestock guarding animals to reduce predation on livestock. Sheep and Goat Research Journal 19:72-75.

Andersen, D. E., O. J. Rongstad, and W. R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. Condor 91:296-299.

Anderson, E. M., and M. J. Lovallo. 2003. Bobcat and lynx. Pp 758-786 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

APHIS Veterinary Services. 2008. Cattle and calves predator death loss in the United States, 2005. National Health Monitoring System, Ft. Collins, Colorado. 56 pp.

APHIS Veterinary Services. 2012. Cattle and calves predator loss in the United States, 2010. National Health Monitoring System, Ft. Collins, Colorado. 39 pp.

APHIS Veterinary Services. 2015. Sheep and lamb predator and nonpredator death loss in the United States, 2015. National Health Monitoring System, Ft. Collins, Colorado. 64 pp.

APHIS Veterinary Services. 2017. Death loss in U.S. cattle and calves due to predator and nonpredator causes, 2015. National Health Monitoring System, Ft. Collins, Colorado. 85 pp.

Archer, J. 1999. The nature of grief: the evolution and psychology of reactions to loss. Taylor & Francis/Routledge, Florence, Kentucky.

Association of Fish and Wildlife Agencies. 2014. Best management practices for trapping beaver in the United States. http://jjcdev.com/~fishwild/?section=best_management_practices. Accessed November 3, 2014.

Association of State Wetland Managers. 2013. Oklahoma and the national wetlands inventory. http://aswm.org/pdf_lib/mapping_2013/oklahoma.pdf. Accessed September 26, 2014.

Awbrey, F. T., and A. E. Bowles. 1990. The effects of aircraft noise and sonic booms on raptors: a preliminary model and a synthesis of the literature on disturbance. Noise and Sonic Boom Impact Technology, Technical Operating Report 12. Wright-Patterson Air Force Base, Ohio.

Bailey, E. P. 1993. Introduction of foxes to Alaska islands – history, effects on avifauna, and eradication. Resourc. Publ. 193, U. S . Fish and Wildlife Serv. Washington, D.C. 53 pp.

Bailey, T. N. 1972. Ecology of bobcats with special reference to social organization. Thesis, University of Idaho, Moscow, Idaho.

Baker, R. O., and R. M. Timm. 1998. Management of conflicts between urban coyotes and humans in southern California. Proc. Vertebrate Pest Conf. 18:299-312.

Baker, P. J., B. Luigi, S. Harris, G. Saunders, and P. C. L. White. 2008. Terrestrial carnivores and human food production: impact and management. Mammal Review 38:123-166.

Ballard, W. B., D. Lutz, T. W. Keegan, L. H. Carpenter, and J. C. deVos, Jr. 2001. Deer-predator relationships: a review of recent North American studies with emphasis on mule and black-tailed deer. Wildlife Society Bulletin 29:99-115.

Barrows, P. L. 2004. Professional, ethical, and legal dilemmas of trap-neuter-release. Journal of the American Veterinary Medical Association 225:1365–1369.

Bateson, P. 1991. Assessment of pain in animals. Animal Behaviour 42:827-839.

Beasom, S. L. 1974. Relationships between predator removal and white-tailed deer net productivity. Journal of Wildlife Management 38:854–859.

Bekoff, M. 1982. Coyote. Pp 447–459 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America: biology, management, and economics. Johns Hopkins University Press, Baltimore, Maryland.

Bekoff, M., and E. M. Gese. 2003. Coyote. Pp 467-481 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Belanger, L., and J. Bedard. 1989. Responses of staging greater snow geese to disturbance. Journal of Wildlife Management 53:713-719.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management 54:36-41.

Bellrose, F. C. 1976. Ducks, geese and swans of North America. Stackpole, Harrisburg, Pennsylvania.

Beran, G. W. 1994**.** Handbook of zoonoses. CRC Press, Boca Raton, Florida.

Berger, J., P. B. Stacey, L. Bellis, and M. P. Johnson. 2001. A mammalian predator-prey imbalance: grizzly bear and wolf extinction affect avian neotropical migrants. Ecological Applications 11:947-960.

Berger, K. M., and M. M. Conner. 2008. Recolonizing wolves and mesopredator suppression of coyotes: impacts on pronghorn population dynamics. Ecological Applications 18:599–612.

Berger, K. M., E. M. Gese, and J. Berger. 2008. Indirect effects and traditional trophic cascades: a test involving wolves, coyotes, and pronghorn. Ecology 89:818–828.

Bergman, D. L., S. W. Breck, and S. C. Bender. 2009. Dogs gone wild: Feral dog damage in the United States. Proceedings of the Wildlife Damage Management Conference 13:177-183.

Bergstrom, B. J., L. C. Arias, A. D. Davidson, A. W. Ferguson, L. A. Randa, and S. R. Sheffield. 2014. License to kill: reforming federal wildlife control to restore biodiversity and ecosystem function. Conservation Letters 7:131–142.

Berryman, J. H. 1991. Animal damage management: Responsibilities of various agencies and the need for coordination and support. Proc. East. Wildl. Damage Control Conf. 5:12-14.

Berthier, K., M. Langlais, P. Auger, and D. Pontier. 2000. Dynamics of a feline virus with two transmission modes within exponentially growing host populations. Proc. Biol. Sci. 267: 2049–2056.

Beschta, R. L., D. L. Donahue, D. A. Dellasala, J. J. Rhodes, J. R. Karr, M. H. O'Brien, T. L. Fleischner, and C. Deacon Williams. 2013. Adapting to climate change on western public lands: Addressing the ecological effects of domestic, wild, and feral ungulates. Environmental Management 51:474–491.

Beschta, R. L., and W. J. Ripple. 2006. River channel dynamics following extirpation of wolves in northwestern Yellowstone National Park, USA. Earth Surface Processes and Landforms 31:1525–1539.

Beschta, R. L., and W. J. Ripple. 2008. Wolves, trophic cascades, and rivers in the Olympic National Park, USA. Ecohydrology 1:118-130.

Beschta, R. L. and W. J. Ripple. 2012*a*. Berry-producing shrub characteristics following wolf reintroduction in Yellowstone National Park. Forest Ecology and Management 276:132-138.

Beschta, R. L. and W. J. Ripple. 2012*b*. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157-158:88-98.

Bevins, S., E. Blizzard, L. Bazan, and P. Whitley. 2013. *Neospora caninum* exposure in overlapping populations of coyotes (*Canis latrans*) and feral swine (*Sus scrofa*). Journal of Wildlife Diseases 49:1028-1032.

Bishop, R. C. 1987. Economic values defined. Pages 24 -33 *in* D. J. Decker and G. R. Goff, editors. Valuing wildlife: economic and social perspectives. Westview Press, Boulder, Colorado.

Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66:451-462.

Blunden, J., and D. S. Arndt, Eds. 2013. State of the climate in 2012. Bulletin of the American Meteorological Society 94:S1-S238.

Boddicker, M. L. 1980. Managing Rocky Mountain Furbearers. Colorado Trapper's Assoc. Training Manual. 181 pp.

Bodenchuk, M. J., J. R. Mason, and W. C. Pitt. 2002. Economics of predation management in relation to agriculture, wildlife, and human health and safety. Pages 80-90 *in* Clark, L., J. Hone, J. A. Shivik, R. A. Watkins, K. C. Vercauteren, And J. K. Yoder, eds. Human conflicts with wildlife: economic considerations. Proceedings of the Third NWRC Special Symposium. National Wildlife Research Center, Fort Collins, Colorado, USA.

Boggess, E. K. 1994*a*. Mink. Pp C89-C92 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Boggess, E. K. 1994*b*. Raccoons. Pp C101-C107 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Bomford, M. 1990. Ineffectiveness of a sonic device for deterring starlings. Wildlife Society Bulletin 18:151-156.

Borg, E. 1979. Physiological aspects of the effects of sound on man and animals. Acta Oto-laryn-gologica, Supplement 360:80-85.

Bourne, J., and M. Dorrance. 1982. A field test of lithium chloride aversion to reduce coyote predation on domestic sheep. Journal of Wildlife Management 46:235-239.

Bouwer, H. 1989. The Bouwer and Rice slug test--an update. Ground Water 27:304-309.

Boyce, P. S. 1998. The social construction of bereavement: an application to pet loss. Thesis, University of New York.

Brasheres, J. S., L. R. Prugh, C. J. Stoner, and C. W. Epps. 2010. Ecological and conservation implications of mesopredator release. Pages 221-240 *in* J. Terborgh and J. A. Estes, eds., Trophic Cascades: Predators, Prey and the Changing Dynamics of Nature, Island Press, Washington, D.C.

Bromley, C., and E. M. Gese. 2001*a*. Surgical sterilization as a method of reducing coyote predation on domestic sheep. Journal of Wildlife Management 65:510-519.

Bromley, C., and E. M. Gese. 2001*b*. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Canadian Journal of Zoology 79:386-392.

Burns, R. J. 1980. Evaluation of conditioned predation aversion for controlling coyote predation. Journal of Wildlife Management 44:938-942.

Burns, R. J. 1983. Coyote predation aversion with lithium chloride: management implications and comments. Wildlife Society Bulletin 11:128-133.

Burns, R. J., and G. E. Connolly. 1980. Lithium chloride aversion did not influence prey killing in coyotes. Proceeding of the Vertebrate Pest Conference 9:200-204.

Burns, R. J., and G. E. Connolly. 1985. A comment on "coyote control and taste aversion." Appetite 6:276-281.

Cain, S., A. Kadlec, D. L. Allen, R. A. Cooley, M. C. Hornocker, A. S. Leopold, and F. H. Wagner. 1972. Predator control-1971 report to the Council on Environmental Quality and the Department of the Interior by the Advisory Committee on Predator Control. Council on Environmental Quality and U.S. Department of the Interior, Washington, D.C., USA.

Camenzind, F. J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson Wyoming. Pp 267-294 *in* M. Bekoff, ed. Coyotes: biology, behavior and management. Academic Press, New York, New York.

Canadian Broadcast Company. 2009. Coyotes kill Toronto singer in Cape Breton. http://www.cbc.ca/news/canada/nova-scotia/story/2009/10/28/ns-coyote-attack-died.html. Accessed January 17, 2016.

Cardinale, B. J., J. E. Duffy, A. Gonzalez, D. U. Hooper, C. Perrings, P. Venail, A. Narwani, G. M. Mace, D. Tilman, D. A.Wardle, A. P. Kinzig, G. C. Daily, M. Loreau, J. B. Grace, A. Larigauderie, D. S. Srivastava, and S. Naeem. 2012. Biodiversity loss and its impact on humanity. Nature 486:59–67.

Castillo, D., and A. L. Clarke. 2003. Trap/neuter/release methods ineffective in controlling domestic cat "colonies' on public lands. Natural Areas Journal 23:247-253.

CDC. 1999. Mass treatment of humans who drank unpasteurized milk from rabid cows – Massachusetts, 1996-1998. CDC – Morbidity and Mortality Weekly Report. 48:228-229.

CDC. 2011. Rabies. http://www.cdc.gov/rabies/index.html. Accessed July 23, 2012.

Chamberlain, M. J., and B. D. Leopold. 2001. Omnivorous furbearers. Pages 278-292 *in* J. G. Dickson editor. Wildlife of southern forests: habitat and management. Hancock House Publishers, Blaine, Washington.

Chitty, D. 1967. The natural selection of self-regulatory behavior in animal populations. Proceedings of the Ecological Society 2:51-78.

Churcher, P. B., and J. H. Lawton. 1987. Predation by domestic cats in an English village. Journal of Zoology (London) 212:439-455.

Clark, F. W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management 36:343-356.

Coleman, J. S., and S. A. Temple. 1989. Effects of free ranging cats on wildlife: a progress report. Proceedings of the Eastern Wildlife Damage Control Conference 4:9-12.

Commissioners of the Land Office. 2015. 2015 annual report. State of Oklahoma, Commissioners of the Land Office. 21 pp.

Connolly, G. E. 1978. Predator control and coyote populations: A review of simulation models. Pp 327-345 *in* M. Bekoff, ed. Coyotes: Biology, Behavior and Management. Academic Press, New York. 384 pp.

Connolly, G. E. 1992. Coyote damage to livestock and other resources. Pp 161-169 *in* A.H. Boer, ed. Ecology and management of the eastern coyote. Wildlife Research Unit. University of New Brunswick, Fredericton, New Brunswick, Canada.

Connolly, G. E. 1995. The effects of control on coyote populations: another look. pp 23-29 *in:* D. Rollins, C. Richardson, T. Blankenship, K. Canon, and S. Henke, eds. Proc. of symposium: Coyotes in the southwest: a compendium of our knowledge. Texas Parks and Wildl. Dept., Austin, Texas.

Connolly, G. E., and B. W. O'Gara. 1987. Aerial hunting takes sheep-killing coyotes in Western Montana. Proc. Great Plains Wildl. Damage Control Workshop 8:184-188.

Connolly, G. E., and W. M. Longhurst. 1975. The effects of control on coyote populations. Univ. Calif., Div. Agric. Sci. Bull. 1872. 37 pp.

Conomy, J. T., J. A. Dubovsky, J. A. Collazo, and W. J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management 62:1135-1142.

Conover, M. R. 1982. Behavioral techniques to reduce bird damage to blueberries: Methiocarb and a hawk-kite predator model. Wildlife Society Bulletin 10:211-216.

Conover, M. R. 1998. Perceptions of American agricultural producers about wildlife on their farms and ranches. Wildlife Society Bulletin 26:597-604.

Conover, M. R. 2002. Resolving human-wildlife conflicts: the Science of Wildlife Damage Management. Lewis Publ., New York, New York.

Conover, M. R., W. C. Pitt, K. K. Kessler, T. J. DuBow, and W. A. Sanborn. 1995. Review of human injuries, illness, and economic losses caused by wildlife in the United States. Wildlife Society Bulletin 23:407-414.

Conover, M. R., J. G. Francik, and D. E. Miller. 1977. An experimental evaluation of aversive conditioning for controlling coyote predation. Journal of Wildlife Management 41:775-779.

Coolahan, C. 1990. The use of dogs and calls to take coyotes around dens and resting areas. Proceedings of the Vertebrate Pest Conference 14:260-262.

Cote, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395-404.

Craig, J. R., J. D. Rimstidt, C. A. Bonnaffon, T. K. Collins, and P. F. Scanlon. 1999. Surface water transport of lead at a shooting range. Bull. Environ. Contam. Toxicol. 63:312-319.

Crain, A. R., J. L. Belant, and T. L. DeVault. 2015. Carnivore incidents with U.S. civil aircraft. Transportation Research 36:160-166.

Craven, S. R., T. Barnes, and G. Kania. 1998. Toward a professional position on the translocation of problem wildlife. Wildlife Society Bulletin 26:171-177.

Crawford, B. A., M. R. Pelton, and K. G. Johnson. 1993. Techniques to monitor relative abundance of coyotes in East Tennessee. Proceedings of Annual Conference, Southeastern Association of Fish and Wildlife Agencies 47:62-70.

Crooks, K., and M. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563–566.

Crowe, D. M. 1975. A model for exploited bobcat populations in Wyoming. Journal of Wildlife Management 39:408-415.

Cypher, B. L. 2003. Foxes. Pages 511-546 *in* Wild Mammals of North America. G.A. Feldhamer, B.C. Thompson, and J. A. Chapman, eds. The Johns Hopkins University Press, Baltimore, Maryland, USA.

Daniel, T. C., A. Muhar, A. Arnberger, O. Aznar, J. W. Boyd, K. M. a. Chan, R. Costanza, T. Elmqvist, C. G. Flint, P. H. Gobster, A. Gret-Regamey, R. Lave, S. Muhar, M. Penker, R. G. Ribe, T. Schauppenlehner, T. Sikor, I. Soloviy, M. Spierenburg, K. Taczanowska, J. Tam, and A. von der Dunk. 2012. Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences 109:8812–8819.

Danner, D. A., and N. S. Smith. 1980. Coyote home range, movement, and relative abundance near a cattle feedyard. Journal of Wildlife Management 44:484-487.

Dauphine, N., and R. J. Cooper. 2009. Impacts of free-ranging domestic cats (*Felix catus*) on birds in the United States: A review of recent research with conservation and management recommendations. Proceedings of the fourth international partners in flight conference: tundra to tropics., McAllen, Texas. http://www.abcbirds.org/abcprograms/policy/cats/pdf/impacts_of_free_ranging_domestic_cats.pdf. Accessed July 23, 2012.

Davidson, W. R. 2006. Field manual of wildlife diseases in the southeastern United States. Third edition. The University of Georgia, Athens. 448 pp.

Davidson-Nelson, S. J., and T. M. Gehring. 2010. Testing fladry as a nonlethal management tool for wolves and coyotes in Michigan. Human-Wildlife Interactions 4:87-94.

Davis, J. 2014. Expansion of the river otter and its trapping limits. Your side of the Fence, Oklahoma Department of Wildlife Conservation. 8 pp.

deCalesta, D. S., and M. G. Cropsey. 1978. Field test of a coyote-proof fence. Wildlife Society bulletin 6:256-259.

Decker, D. J., and G. R. Goff. 1987. Valuing wildlife: economic and social perspectives. Westview Press, Boulder, Colorado.

Decker, D. J., and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildlife Society Bulletin 16:53-57.

Decker, D. J., and L. C. Chase. 1997. Human dimensions of living with wildlife – a management challenge for the 21st century. Wildlife Society Bulletin 28:4-15.

Decker, D. J., and T. L. Brown. 2001. Understanding your stakeholders. Pages 109-132 *in* D.J. Decker, T. L. Brown, and W.F. Siemer, eds. Human Dimensions of Wildlife Management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

de Groot, R. S., M. A. Wilson, and R. M. J. Boumans. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41:393–408.

DeLiberto, T. J., E. M. Gese, F. F. Knowlton, J. R. Mason, M. R. Conover, L. Miller, R. H. Schmidt, and M. K. Holland. 1998. Fertility control in coyotes: is it a potential management tool? Proceedings of the Vertebrate Pest Conference 18:144-149.

DeLorenzo, D. G., and V. W. Howard, Jr. 1977. Evaluation of sheep losses on a range lambing operation in southeastern New Mexico. N. Mex. State Univ. Agri. Exp. Sta. Res. Rep. 341.

DeVos, J. C. and J. L. Smith. 1995. Natural mortality in wildlife populations. Intl. Assoc. of Fish and Wildlife Agencies, Washington, D.C. 50 pp.

Diamond, J. 1992. Must we shoot deer to save nature? Natural History. New York, August 2.

Dickens, M. J., D. J. Delehanty, and L. M. Romero. 2010. Stress: an inevitable component of animal translocations. Biological Conservation 143:1329-1341.

Diefenbach, D. R., L. A. Hansen, R. J. Warren, and M. J. Conroy. 2006. Spatial organization of a reintroduced population of bobcats. Journal of Mammalogy 87:394−401.

Dolbeer, R.A. 1998. Population dynamics: the foundation of wildlife damage management for the 21st century. Pp. 2-11 *in* Barker, R. O. and Crabb, A. C., Eds. Eighteenth Vertebrate Pest Conference (March 2-5, 1998, Costa Mesa, California). University of California at Davis, Davis, California, USA.

Dolbeer, R. A. 2000. Birds and aircraft: Fighting for airspace in crowded skies. Proceedings of the Vertebrate Pest Conference 19:37-43.

Dolbeer, R. A. 2009. Birds and aircraft: fighting for airspace in ever more crowded skies. Human-Wildlife Conflicts 3:165-166.

Dolbeer, R. A., G. E. Bernhardt, T. W. Seamans and P. P. Woronecki. 1991. Efficacy of two gas cartridge formulations in killing woodchucks in burrows. Wildlife Society Bulletin 19:200-204.

Dolbeer, R. A., P. P. Woronecki, and R. L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. Wildlife Society Bulletin 14:418-425.

Dolbeer, R. A., S. E. Wright, J. R. Weller, A. L. Anderson, and M. J. Begier. 2015. Wildlife strikes to civil aircraft in the United States 1990–2014, Serial report 21. U.S. Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C., USA.

Dubey, J. P. 1973. Feline toxoplasmosis and coccidiosis: a survey of domiciled and stray cats. Journal of American Veterinary Medical Association 162:873-877.

Dubey, J. P. , R. M. Weigel, A. M. Siegel, P. Thulliez, U. D. Kitron, M. A. Mitchell, A. Mannelli, N. E. Mateus-Pinilla, S. K. Shen, O. C. H. Kwok, and K. S. Todd. 1995. Sources and reservoirs of *Toxoplasma gondii* infection on 47 swine farms in Illinois. J. Parasitol. 81:723-729.

Eagle, T. C., and J. S. Whitman. 1987. Mink. Pp 614-625 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Ellins, S. R., and G. C. Martin. 1981. Olfactory discrimination of lithium chloride by the coyote (*Canis latrans*). Behavioral and Neural Biology 31:214-224.

Ellis, D. H. 1981. Responses of Raptorial Birds to low level military jets and sonic booms: Results of the 1980-1981 Joint U.S. Air Force-U.S. Fish and Wildlife Service Study. Prepared by the Institute for Raptor Studies for USAF and USFWS. NTIS No. ADA 108-778.

EPA. 1986. Quality Criteria for Water 1986. U.S. Environmental Protection Agency, Publication EPA/440/5-86-001. Washington, D.C., USA.

EPA. 1991. Reregistration eligibility document: Inorganic nitrate/nitrite (sodium and potassium nitrates). List D, Case 4052. Environmental Protection Agency, Office of Pesticide Programs Special Review and Reregistration Division, Washington, D.C., USA.

EPA. 1994. Reregistration eligibility document: Sodium cyanide. Office of Prevention, Pesticides and Toxic Substances. EPA-738-F-94-016. 4 pp.

EPA. 2000. Introduction to phytoremediation. EPA/600/R-99/107, Office of Research and Development, Washington, D.C., USA.

EPA. 2009. Response letter from D. Edwards, EPA, to W. Keefover-Ring, Sinapu et al., Dated January 16, 2009. http://www.epa.gov/espp/litstatus/effects/2011/sodium-cyanide/2007-0944-0864.pdf. Accessed December 27, 2013.

EPA. 2016. Climate change on ecosystems. https://www.epa.gov/climate-impacts/climate-impacts-ecosystems. Accessed October 11, 2016.

Erickson, D. W., C. R. McCullough, and W. R. Poranth. 1984. Evaluation of experimental river otter reintroducutions. Final Report of Missouri Department of Conservation. Federal Aid Project. No. W-13-R-38. 47.

Errington, P. L. 1933. Bobwhite winter survival in an area heavily populated with grey fox. Iowa State College Journal of Science 8:127–130.

Errington, P. L. 1943. An analysis of mink predation upon muskrats in north-central United States. Iowa Agricultural Experiment Station Research Bulletin 320:797-924.

Estes, J. A., J. Terborgh, J. S. Brashares, M. E. Power, J. Berger, W. J. Bond, S. R. Carpenter, T. E. Essington, R. D. Holt, J. B. C. Jackson, R. J. Marquis, L. Oskanen, T. Oskanen, R. T. Paine, E. K. Pikitch, W. J. Ripple, S. A. Sandin, M. Scheffer, T. W. Schoener, J. B. Shurin, A. R. E. Sinclair, M. E. Soule, R. Virtanen, and D. A. Wardle. 2011. Trophic downgrading of planet earth. Science 333:301–307.

Fancy, S. G. 1982. Reaction of bison to aerial surveys in interior Alaska. Canadian Field Naturalist 96:91.

FAA. 2017. FAA National Wildlife Aircraft Strike Database 2017. U. S. Department of Transportation, Federal Aviation Administration, 800 Independence Avenue, SW, Washington, D.C., USA.

Federal Emergency Management Agency. 2005. Dam Owner's Guide to Animal Impacts on Earthen Dams. FEMA L-264.

Fitzgerald, B. M., W. B. Johnson, C. M. King, and P. J. Moors. 1984. Research on Mustelids and cats in New Zealand. WRLG Res. Review No. 3. Wildl. Res. Liaison Group, Wellington. 22 pp.

Fitzwater, W. D. 1994. Feral house cats. Pp C45-50 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Follmann, E. H. 1973. Comparative ecology and behavior of red and gray fox. Thesis, Southern Illinois University-Carbondale, Carbondale, Illinois.

Ford, J. 2016. Bear harvest totals 52 for 2015 season. 2015-2016 Big Game Report. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma.

Forthman-Quick, D. L., C. R. Gustavson, and K. W. Rusiniak. 1985*a*. Coyote control and taste aversion. Appetite 6:253-264.

Forthman-Quick, D. L., C. R. Gustavson, and K. W. Rusiniak. 1985*b*. Coyotes and taste aversion: The authors' reply. Appetite 6:284-290.

Fox, C. H. 2008. Analysis of the Marin County strategic plan for protection of livestock and wildlife: An alternative to traditional predator control. M. A. Thesis, Prescott College, Prescott, Arizona, USA.

Frank, D. A. 2008. Evidence for top predator control of a grazing ecosystem. Oikos 117:1718-1724.

Fraser, J. D., L. D. Frenzel, and J. E. Mathisen. 1985. The impact of human activities on breeding bald eagles in north-central Minnesota. Journal of Wildlife Management 49:585-592.

Fritzell, E. K. 1987. Gray fox and island fox. Pp 408-420 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Fuller, M. R., and J. A. Mosher. 1987. Raptor survey techniques. Pages 37-65 *in* B. A. Giron Pendleton, B.A Millsap, K. W. Cline, and D. M. Bird, editors. Raptor management techniques manual. National Wildlife Federation, Washington, D.C., USA.

Fuller, T. K., W. E. Berg, and D. W. Kuehn. 1985. Survival rates and mortality factors of adult bobcats in north-central Minnesota. Journal of Wildlife Management 49:292-296.

Fuller, W. A. 1969. Changes in number of three species of small rodents near Great Slave Lake, Northwest Territories, Canada, 1964-1967 and their significance for general population theory. Annales Zoologici Fennici 6:113-144.

Gantz, G. 1990. Seasonal movement pattern of coyotes in the Bear River Mountains of Utah and Idaho. Thesis, Utah State University, Logan, Utah, USA.

Gardner, A .L. 1982. Virginia opossum. Pp 3-36 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America: biology, management, and economics. Johns Hopkins University Press, Baltimore, Maryland.

Gardner, A. L., and M. E. Sunquist. 2003. Opossum. Pp 3-29 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Gehring, T. M., K. C. VerCauteren, and J. Landry. 2010*b*. Livestock protection dogs in the 21st Century: Is an ancient tool relevant to modern conservation challenges? BioScience 60:299-308.

Gehring, T. M., K. C. VerCauteren, M. L. Provost, and A. C. Cellar. 2010*a*. Utility of livestock-protection dogs for deterring wildlife from cattle farms. Wildlife Research 37:715-721.

Gehrt, S. D. 2003. Raccoon. Pp 611-634 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Geist, V. 2006. The North American model of wildlife conservation. Pages 285-293 *in* D. M. Lavigne, ed. Gaining ground: In Pursuit of Ecological Sustainability. Int. Fund for Animal Welfare.

Gerell, R. 1971. Population studies on mink, *Mustela vison* Schreber, in southern Sweden. Viltrevy 8:83-114.

Gerwolls, M. K., and S. M. Labott. 1994. Adjustment to the death of a companion animal. Anthrozoos 7:172-187.

Gese, E. M. 1998. Response of neighboring coyotes (*Canis latrans*) to social disruption in an adjacent pack. Canadian Journal of Zoology 76:1960-1963.

Gese, E. M. 2005. Demographic and Spatial Responses of Coyotes to Changes in Food and Exploitation. Pages 271–285 *in*. D. L. Nolte, and K. A. Fagerstone, eds., Proceedings of the 11th Wildlife Damage Management Conference.

Gese, E. M., M. Bekoff, W. Andelt, L. Carbyn, and F. Knowlton. 2008. Canis latrans. The IUCN Red List of Threatened Species 2008: e.T3745A10056342. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T3745A10056342.en. Accessed January 3, 2018.

Gese E. M., R. L. Ruff, and R. L. Crabtree. 1996. Foraging ecology of coyotes *(Canis latrans)*: The influence of extrinsic factors and a dominance hierarchy. Canadian Journal of Zoology 74:769-783.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1988. Home range and habitat use of coyotes in southeastern Colorado. Journal of Wildlife Management 52:640-646.

Gier, H. T. 1948. Rabies in the wild. Journal of Wildlife Management 12:142–153.

Gier, H. T. 1968. Coyotes in Kansas, revised edition. Kansas State College of Agriculture, Experimental Station Bulletin 393, Manhattan, Kansas.

Gill, J. L., J. W. Williams, S. T. Jackson, K. B. Lininger, and G. S Robinson. 2009. Pleisotcene megafaunal collapse, novel plant communities and enhanced fire regimes in North America. Science 326:1100-1103.

Gill, R. B. 1999. Declining mule deer populations in Colorado: reasons and responses. Special Report No. 77. Colorado Division of Wildlife. DOW-R-S-77-01. 30 pp.

Gillespie, J. H., and F. W. Scott. 1973. Feline viral infections. Advances in Vet. Sci. and Comp. Med. 17: 163-200.

Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U.S. Fish and Wildlife Service Resource Publication 140.

Gipson, P. S. 1983. Evaluations of behavior of feral dogs in interior Alaska, with control implications. Vertebrate Pest Control Management Materials 4th Symposium. American Society for Testing Materials 4:285-294.

Gladwin, D. N., D. A. Asherin, and K. M. Manci. 1988. Effects of aircraft noise and sonic booms on fish and wildlife. U.S. Fish and Wildlife Service National Ecology Research Center Report 88/30.

Green, J. S., and P. S. Gipson. 1994. Feral dogs. Pp C77-C82 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Green, J. S., and R. A. Woodruff. 1983. The use of three breeds of dog to protect rangeland sheep from predators. Applied Animal Ethology 11:141-161.

Green, J. S., and R. A. Woodruff. 1988. Breed comparisons and characteristics of use of livestock guarding dogs. Journal of Range Management 41:249-251.

Green, J. S., F. R. Henderson, and M. D. Collinge. 1994. Coyotes. Pp C51-C76 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-bearing mammals of California. University of California Press, Berkeley, California.

Grubb, T. G., D. K. Delaney, W.W. Bowerman, and M. R. Wierda. 2010. Golden eagle indifference to heli-skiing and military helicopters in Northern Utah. Journal of Wildlife Management 74:1275–1285.

Gunderson, L. H. 2000. Ecological resilience – in theory and application. Annual Review of Ecology and Systematics 31:425-439.

Gustavson, C. R., J. Garcia, W. G. Hankins, and K. W. Rusiniak. 1974. Coyote predation control by aversive conditioning. Science 184:581-583.

Gustavson, C. R., J. R. Jowsey, and D. N. Milligan. 1982. A 3-year evaluation of taste aversion coyote control in Saskatchewan. J. Range Manage. 35:57-59.

Guthery, F. S., and S. L. Beasom. 1977. Responses of game and nongame wildlife to predator control in South Texas. Journal of Range Management 30:404-409.

Guthery, F. S., and S. L. Beasom. 1978. Effects of predator control on Angora goat survival in South Texas. Journal of Range Management 31:168-173.

Hall, D. I. 1979. An ecological study of the coyote-like canid in Louisiana. M.S. Thesis. Louisiana State University. Baton Rouge, Louisiana. 234 pp.

Hallberg, D.L., and G.R. Trapp. 1984. Gray fox temporal and spatial activity in a riparian–agricultural zone in California's Central Valley. Pp 920-928 *in* R. E. Warner and K. M. Hendrix, eds. Proceedings of the California Riparian Systems Conference. University of California Press, Berkeley, California.

Hamilton, D. A. 1982. Ecology of the bobcat in Missouri. Thesis, University of Missouri, Columbia, Missouri.

Haroldson, K. J., and E. K. Fritzell. 1984. Home ranges, activity, and habitat use by gray fox in an oak–hickory forest. Journal of Wildlife Management 48:222-227.

Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (*Vulpes vulpes*) population. Mammal Review 7: 25-39.

Harris, S. 1979. Age related fertility and productivity in red fox, *Vulpes vulpes*, in suburban London. Journal of Zoology (London) 187:195-199.

Harris, S, and J.M.V. Rayner. 1986. Urban fox (*Vulpes vulpe*s) population estimates and habitat requirements in several British cities. Journal of Animal Ecology 55:575–591.

Hatler, D. F. 1976. The coastal mink of Vancouver Island, British Columbia. Ph. D. Thesis. Univ. of British Columbia, Canada.

Henke, S. E. 1992. Effect of coyote removal on the faunal community ecology of a short-grass prairie. Dissertation, Texas Tech University, Lubbock, Texas, USA.

Henke, S. E. 1995. Effects of coyote control on their prey: A review. Pages 35–40 *in* Coyotes in the Southwest: A Compendium of Our Knowledge.

Henke, S. E., and F. C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. Journal of Wildlife Management 63:1066–1081.

Henne, D. R. 1975. Domestic sheep mortality on a western Montana ranch. M. S. Thesis. University of Montana. Missoula, Montana. 64 pp.

Herrero, S. 1985. Bear attacks: their causes and avoidance. New Century Publications, Piscataway, New Jersey.

Holthuijzen, A. M. A., W. G. Eastland, A. R. Ansell, M. N. Kochert, R. D. Williams, and L. S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281.

Horn, S. W. 1983. An evaluation of predatory suppression in coyotes using lithium chloride-induced illness. Journal of Wildlife Management 47:999-1009.

Howard, V. W., Jr., and R. E. Shaw. 1978. Preliminary assessment of predator damage to the sheep industry in southeastern New Mexico. Agric. Exp. Stn., Colorado State Univ., Las Cruces, Res. Rpt. 356.

Howard, V. W., Jr., and T. W. Booth. 1981. Domestic sheep mortality in southeastern New Mexico. Agric. Exp. Stn., Colo. State Univ., Las Cruces. Bull. #683.

Howell, R. G. 1982. The urban coyote problem in Los Angeles County. Proc. Vertebr. Pest Conf. 10:21-23.

International Association of Fish and Wildlife Agencies. 2005. Potential costs of losing hunting and trapping as wildlife management tools. Animal Use Committee, International Association of Fish and Wildlife Agencies, Washington, D.C. 52 pp.

Jackson, J. J. 1994. Opossums. Pp D59-D64 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Jahnke, L. J., C. Phillips, S. H. Anderson, and L. L. McDonald. 1987. A methodology for identifying sources of indirect costs of predation control: A study of Wyoming sheep producers. Vertebr. Pest. Cont. Manage. Mat. 5, ASTM STP 974. pp 159-169.

Jessup, D. A. 2004. The welfare of feral cats and wildlife. Journal of the American Veterinary Medical Association 225:1377-1382.

Johnson, E. L. 1984. Applications to use sodium fluoroacetate (Compound 1080) to control predators; final decision. Fed. Reg. 49(27):4830-4836.

Johnson, M.R., R.G. McLean, and D. Slate. 2001. Field operations manual for the use of immobilizing and euthanizing drugs. USDA, APHIS, WS Operational Support Staff, Riverdale, Maryland, USA.

Keirn, G., J. Cepek, B. Blackwell, and T. DeVault. 2010. On a quest for safer skies: Managing the growing threat of wildlife hazards to aviation. The Wildlife Professional, Summer 2010: 52-55.

Keith, L. B. 1963. Wildlife's ten-year cycle. University of Wisconsin Press, Madison, Wisconsin. 201 pp.

Keith, L. B. 1974. Some features of population dynamics in mammals. International Congress on Game Biology 11:17-59.

Kendall, R. J., T. E. Lacher Jr., C. Bunck, F. B. Daniel, C. Driver, C. E. Grue, F. Leighton, W. Stansley, P. G. Watanabe, and M. Whitworth. 1996. An ecological risk assessment of lead shot exposure in non-waterfowl avian species: upland game birds and raptors. Environmental Toxicology and Chemistry 15:4-20.

Kennedy, M. L., J. P. Nelson, Jr., F. W. Weckerly, D. W. Sugg, and J. C. Stroh. 1991. An assessment of selected forest factors and lake level in raccoon management. Wildlife Society Bulletin 19:151-154.

Kennelly, J. J., and B. E. Johns. 1976. The estrous cycle of coyotes. Journal of Wildlife Management 40:272-277.

Kern, W. H., Jr. 2002. Raccoons. WEC-34. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Knowlton, F. F. 1964. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Dissertation, Purdue University, Lafayette, Illinois, USA.

Knowlton, F. F. 1972. Preliminary interpretations of coyote population mechanics with some management implications. Journal of Wildlife Management 36:369-383.

Knowlton, F. F., and L.C. Stoddart. 1985. Coyote population mechanics: Another look. Pp 93-111 *in* F.L. Bunnell, D.S. Eastman, and J.M. Peck, eds. Symposium on the Natural Regulation of Wildlife Populations. University of Idaho, Moscow, Idaho.

Knowlton, F. F., E. M. Gese, and M. M. Jeager. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52:398-412.

Krausman, P. R., and J. J. Hervert. 1983. Mountain sheep responses to aerial surveys. Wildlife Society Bulletin 11:372-375.

Krausman, P. R., L. K. Harris, C. L. Blasch, K. K. G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs 157.

Krausman, P. R., B. D. Leopold, and D. L. Scarborough. 1986. Desert mule deer responses to aircraft. Wildlife Society Bulletin 13:71-73.

Krebs, J. W., C.E., Rupprecht, and J.E. Childs. 2000. Rabies surveillance in the United States during 1999. Journal of the American Veterinary Medical Association 217:1799-1811.

Krebs, C. J., R. Boonstra, S. Boutin, and A. R. E. Sinclair. 2001. What drives the 10-year cycle of snowshoe hares? Bioscience 51:25-35.

Kreeger, T. J., P. J. White, U. S. Seal, and J. R. Tester. 1990. Pathophysiological Responses of Red Foxes to Foothold Traps. Journal of Wildlife Management 54:147-160.

Kushlan, J. A. 1979. Effects of helicopter censuses on wading bird colonies. Journal of Wildlife Management 43:756-760.

Laidlaw, M. A. S., H. W. Mielke, G. M. Filippelli, D. L. Johnson, and C. R. Gonzales. 2005. Seasonality and children's blood lead levels: developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana (USA). Environ Health Perspect. 113793–800.800doi:10.1289/ehp.7759.

Larivière, S. 2003. Mink. Pp 662-671 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Lawhead, D. N. 1984. Bobcat (*Lynx rufus*) home range, density and habitat preference in South-Central Arizona. The Southwestern Naturalist 29:105-113.

Lamp, R. E. 1989. Monitoring of the effect of military air operations at naval air station Fallon on the biota of Nevada. Nevada Department of Wildlife, Reno, Nevada.

Lancia, R. A., C. S. Rosenberry, and M. C. Conner. 2000. Population parameters and their estimation. Pages 64-83 *in* S. Demaris and P. R. Krausman, editors. Ecology and management of large mammals in North America. Prentice-Hall Incorporated, Upper Saddle River, New Jersey.

Larson, S. 2006. The Marin County predator management program: Will it save the sheep industry. Proceedings of the Vertebrate Pest Conference 22:294-297.

Lefrancois, G. R. 1999. The Lifespan. Sixth edition. Wadsworth Publishing Company, Belmont, California, USA.

Lembeck, M. 1978. Bobcat study, San Diego County, California. California Department of Fish and Game, Federal Aid Nongame Wildlife Investigation Project. E-W-2 Report.

Levi, T., and C. Wilmers. 2012. Wolves–coyotes–foxes: a cascade among carnivores. Ecology 93:921–929.

Levy, J. K., and P. C. Crawford. 2004. Humane strategies for controlling feral cat populations. Journal of the American Veterinary Medical Association 225:1354-60.

Lindzey, F. G. 1971. Ecology of badgers in Curlew Valley, Utah and Idaho with emphasis on movements and activity patterns. M.S. Thesis. Utah State University, Logan, Utah, USA.

Lindzey, F. G. 2003. Badger (*Taxidea taxus*). Pages 683-691 in G. A. Feldhamer, B. C. Thompson, and J. A Chapman editors. Wild mammals of North America. The Johns Hopkins University Press, Baltimore, Maryland, USA.

Linhart, S. B., G. J. Dasch, R. B. Johnson, J. D. Roberts, and C. J. Packham. 1992. Electronic frightening devices for reducing coyote predation on domestic sheep: Efficacy under range conditions and operational use. Pages 386-392 *in* J. E. Borrecco and R. E. Marsh, eds., Proceedings of the 15th Vertebrate Pest Conference. University of California-Davis, Davis, California, USA.

Linnell, M. A., M. R. Conover, and T. J. Ohashi. 1996. Analysis of bird strikes at a tropical airport. Journal of Wildlife Management 60:935-945.

Linscombe, G., N. Kinler, and R. J. Aulerich. 1982. Mink. Pp 629-643 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America: biology, management, and economics. Johns Hopkins University Press, Baltimore, Maryland.

Long, D., and S. Henke. 2004. Predators of the underground: The North American badger. South Texas Wildlife, Caesar Kleberg Wildlife Research Institute, Fall 2004, Volume 8, No. 3.

Lord, R. D., Jr. 1961. A population study of the gray fox. American Midland Naturalist Journal 66:87–109.

Loven, J. E. 1995. Coyotes in urban areas: A status report. Pp. 65-67 *in* D. Rollins, C. Richardson, T. Blankenship, K. Canon, and S. Henke, eds. Proc. Coyotes in the Southwest: A compendium of our knowledge. Texas Parks and Wildl. Dept. Austin, Texas.

Lowry, D. A. 1978. Domestic dogs as predators on deer. Wildlife Society Bulletin 6:38-39.

MacDonald, D. W., and M. T. Newdick. 1982. The distribution and ecology of fox, *Vulpes vulpes* (L.), in urban areas. Pp 123–135 *in* R. Bornkamm, J. A. Lee, and M. R. D. Seaward, eds. Urban ecology. Blackwell Scientific Publications, Oxford, United Kingdom.

MacKinnon, B., R. Sowden, and S. Dudley. 2001. Sharing the Skies: an Aviation Guide to the Management of Wildlife Hazards. Transport Canada, Aviation Publishing Division, Tower C, 330 Sparks Street, Ottawa, Ontario, K1A 0N8 Canada. 316 pp.

Majumdar, S. K., J. E. Huffman, F. J. Brenner, and A. I. Panah. 2005. Wildlife diseases: landscape epidemiology, spatial distribution and utilization of remote sensing technology. The Pennsylvania Academy of Sciences.

Manci, K. M., D. N. Gladwin, R. Villella, and M. G. Cavendish. 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: A literature synthesis. Fort Collins, Colorado/ Kearneysville, West Virginia: U.S. Fish and Wildlife Service and National Ecology Research Center.

Marks, S. G., J. E. Koepke, and C. L. Bradley. 1994. Pet attachment and generativity among young adults. Journal of Psychology 128:641-650.

Marlow, M. 2016. No laughing matter: Livestock protection dogs conserve predators too. The Wildlife Professional 10:26-29.

Maron, J. L., and D. E. Pearson. 2011. Vertebrate predators have minimal cascading effects on plant production or seed predation in an intact grassland ecosystem. Ecology Letters 14:661–669.

Marshall, W. H. 1936. A study of the winter activities of the mink. Journal of Mammalogy 17:382-92.

Massei, G., R. J. Quy, J. Gurney, and D. P Cowan. 2010. Can translocation be used to mitigate human-wildlife conflicts? Wildlife Research 37:428-439.

Matchett, M. R., S. W. Breck, and J. Callon. 2013. Efficacy of electronet fencing for excluding coyotes: A case study for enhancing production of black-footed ferrets. Wildlife Society Bulletin 37:893-900.

McCabe, R. A. 1949. Notes on live-trapping mink. Journal of Mammalogy 30:416-423.

McKnight, T. 1964. Feral livestock in Anglo-America. University of California Publications in Geography Vol. 16. University of California Press, Berkeley, California.

Melquist, W. E., and A. E. Dronkert. 1987. River otter. Pp 626-641 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Melquist, W. E., and M. G. Hornocker. 1983. Ecology of river otters in west central Idaho. Wildlife Monographs 83:3-60.

Melquist, W. E., P. J. Polechla, Jr., and D. Toweill. 2003. River otter. Pp 708-734 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Meltzer, M. I. 1996. Assessing the costs and benefits of an oral vaccine for raccoon rabies: a possible model. Emerging Infectious Diseases 2:343-349.

Messick, J. P. 1987. North American badger. Pp 586-597 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Messick, J. P., and M. G. Hornocker. 1981. Ecology of the badger in southwestern Idaho. Wildlife Monographs 76.

Messier, F., and C. Barrette. 1982. The social system of the coyote (*Canis latrans*) in a forested habitat. Can. J. Zool. 60:1743-1753.

Mettler, A. E., and J. A. Shivik. 2007. Dominance and neophobia in coyote (*Canis latrans*) breeding pairs. Applied Animal Behaviour Science 102:85-94.

Meyers, B. 2000. Anticipatory mourning and the human-animal bond. Pp 537-564 *in* T. A. Rando, ed. Clinical dimensions of anticipatory mourning: theory and practice in working with the dying, their loved ones, and their caregivers. Research Press, Champaign, Illinois, USA.

Michaelson, K. A., and J. W. Goertz. 1977. Food habits of coyotes in northwest Louisiana. Proceedings of the Louisiana Academy of Science 40:77–81.

Miller, B. J., H. J. Harlow, T. S. Harlow, D. Biggins, and W. J. Ripple. 2012. Trophic cascades linking wolves (*Canis lupus*), coyotes (*Canis latrans*), and small mammals. Canadian Journal of Zoology 90:70–78.

Miller, E. A., J. K. Young, S. Stelting, and B. A. Kimball. 2014. Efficacy of Ropel® as a coyote repellent. Human-Wildlife Interactions 8:271-278.

Miller, L.A. 1995. Immunocontraception as a tool for controlling reproduction in coyotes. Pp 172-176 *in* D. Rollins, C. Richardson, T. Blankenship, K. Canon, and S. Henke, eds. Coyotes in the Southwest: A Compendium of Our Knowledge. Proc. of a Symposium, Dec. 13-15, Texas A& University, San Angelo, Texas.

Mitchell, B. R., M. M. Jaeger, and R. H. Barrett. 2004. Coyote depredation management: current methods and research needs. Wildlife Society Bulletin 32:1209-1218.

Mitchell, J. L. 1961. Mink movements and populations on a Montana river. Journal of Wildlife Management 25:48-54.

Mouser, J., and A. Schofield. 2015. Oklahoma bobcat management plan. 24 pp.

Mowry, R. A., M. E. Gompper, J. Beringer, and L. S. Eggert. 2011. River otter population size estimation using noninvasive latrine surveys. Journal of Wildlife Management 75:1625-1636.

Muller, L. I., R. J. Warren, and D. L. Evans. 1997. Theory and Practice of immunocontraception in wild animals. Wildlife Society Bulletin 25:504-514.

Munoz, J. R. 1977. Cause of sheep mortality at the Cook Ranch, Florence, Montana. 1975-1976. Thesis, University of Montana, Missoula, Montana, USA.

Myers, J. H., and C. J. Krebs. 1971. Genetic, behavioral, and reproductive attributes of dispersing field voles *Microtus pennsylvanicus* and *Microtus ochrogaster*. Ecological Monographs 41:53-78.

Naiman, R. J., and K. H. Rogers. 1997. Large animals and system-level characteristics in river corridors. BioScience 47:521–529.

Nass, R. D. 1977. Mortality associated with range sheep operations in Idaho. J. Range Manage. 30:253-258.

Nass, R. D. 1980. Efficacy of predator damage control programs. Proc. Vertebrate Pest Conf. 9:205-208.

Nass, R. D., and J. Theade. 1988. Electric fences for reducing sheep losses to predators. Journal of Range Management 41:251-252.

Nass, R. D., G. Lynch, and J. Theade. 1984. Circumstances associated with predation rates on sheep and goats. Journal of Range Management 37:423-426.

NASS. 2000. Sheep and goat predator loss. USDA, National Agricultural Statistics Service, Washington, D.C. 10 pp.

NASS. 2001. Cattle predator loss. USDA, National Agricultural Statistics Service, Washington, D.C. 13 pp.

NASS. 2002. U.S. Wildlife Damage. USDA, National Agricultural Statistics Service, Washington, D.C. 2 pp.

NASS. 2005. Sheep and goat death loss. USDA, National Agricultural Statistics Service, Washington, D.C. 21 pp.

NASS. 2006. Cattle death loss. USDA, National Agricultural Statistics Service, Washington, D.C. 19 pp.

NASS. 2010. Sheep and goats death loss. USDA, National Agricultural Statistics Service, Washington, D.C. 16 pp.

NASS. 2011. Cattle death loss. USDA, National Agricultural Statistics Service, Washington, D.C. 17 pp.

NASS. 2014. 2012 state agriculture overview. USDA, National Agricultural Statistics Service, Washington, D.C.

National Audubon Society. 2000. Field guide to North American mammals. J. O. Whitaker, Jr., editor. Alfred A. Knopf Publishing, New York City, New York.

National Park Service. 1995. Report of effects of aircraft overflights on the National Park System. USDI-NPS D-1062, July, 1995.

Neale, J. C. C., B. N Sacks, M. M. Jaeger, and D. R. McCullough. 1998. A comparison of bobcat and coyote predation on lambs in north-costal California. Journal of Wildlife Management 62:700-706.

Neff, D. J., R. H. Smith, and N. G. Woolsey. 1985. Pronghorn antelope mortality study. Final Report, Federal Aid to Wildlife Restoration Project W-78-R, Arizona Game and Fish Department, Phoenix, Arizona, USA.

Nesbitt, W. H. 1975. Ecology of a feral dog pack on a wildlife refuge. Pp 391-396 *in* M. W. Fox, ed. The wild canids. Van Nostrand Reinhold Company, New York City, New York.

Nicholson, W. S. 1982. An ecological study of the gray fox in east central Alabama. Thesis, Auburn University, Auburn, Alabama.

Nielsen, C. K., and A. Woolf. 2001. Spatial organization of bobcats (*Lynx rufus*) in southern Illinois. American Midland Naturalist 146:43–52.

Nielsen, L. 1988. Definitions, considerations, and guidelines for translocation of wild animals. Pages 12-49 *in* L. Nielsen and R. D. Brown, editors. Translocation of wild animals. Wisconsin Humane Society, Milwaukee, Wisconsin, and Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA.

Noah, D. L., M. G. Smith, J. C. Gotthardt, J. W. Krebs, D. Green, and J. E. Childs. 1995. Mass human exposure to rabies in New Hampshire: Exposures, treatment, and cost. Public Health Briefs, National Center for Infectious Diseases, Atlanta, Georgia, USA.

Nunley, G. L. 1977. The effects of coyote control operations on non-target species in New Mexico. Pages 89–110 *in*. The 3rd Great Plains Wildlife Damage Control Workshop.

Nunley, G. L. 1995. The re-establishment of the coyote in the Edwards Plateau of Texas. Pp. 55-64 *in* D. Rollins, T. Blankenship, S. Henke and K. Canon, editors, Proc. Coyotes in the Southwest: A compendium of our knowledge. San Angelo, Texas, USA.

O'Gara, B. W., K. C. Brawley, J. R. Munoz, and D. R. Henne. 1983. Predation on domestic sheep on a western Montana ranch. Wildlife Society Bulletin 11:253-264.

ODWC. 2005. Oklahoma comprehensive wildlife conservation strategy. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma.

ODWC. 2011*a*. Bobcats. http://www.wildlifedepartment.com/wildlifemgmt/species/bobcat.htm. Accessed October 28, 2016.

ODWC. 2011*b*. Mink. http://www.wildlifedepartment.com/wildlifemgmt/species/mink.htm. Accessed October 28, 2016.

ODWC. 2011*c*. Mountain lion. http://www.wildlifedepartment.com/wildlifemgmt/species/mlion.htm. Accessed October 28, 2016.

ODWC. 2011*d*. Red fox. http://www.wildlifedepartment.com/wildlifemgmt/species/redfox.htm. Accessed October 28, 2016.

ODWC. 2011*e*. River otter. http://www.wildlifedepartment.com/wildlifemgmt/species/otter.htm. Accessed October 28, 2016.

ODWC. 2011*f*. Swift fox. http://www.wildlifedepartment.com/wildlifemgmt/species/swift_fox.htm. Accessed October 28, 2016.

ODWC. 2015. 2015 Annual Report. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 10 pp.

ODWC. 2016*a*. The Oklahoma Department of Wildlife Conservation Mission Statement. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma.

ODWC. 2016*b*. Oklahoma hunting official fall 2016-Spring 2017 regulation guide. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 51 pp.

ODWC. 2016*c*. 2016 post season furbearer report. Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma. 7 pp.

Oklahoma Water Resources Board. 2016. Water facts. https://www.owrb.ok.gov/util/waterfact.php. Accessed October 28, 2016.

Organ, J. F., S. P. Mahoney, and V. Geist. 2010. Born in the hands of hunters, the North American model of wildlife conservation. The Wildlife Professional 4:22-27.

Palmer, B. C., M. R. Conover, and S. N. Frey. 2010. Replication of a 1970s study on domestic sheep losses to predators on Utah's summer rangelands. Rangeland Ecology and Management 63:689-695.

Parker, G. 1995. Eastern coyote: The story of its success. Nimbus Publishing, Halifax, Canada.

Pearson, E. W., and M. Caroline. 1981. Predator control in relation to livestock losses in Central Texas. Journal of Range Management 34:435-441.

Pfeifer, W. K., and M. W. Goos. 1982. Guard dogs and gas exploders as coyote depredation control tools in North Dakota. Proceedings of the Vertebrate Pest Conference 10:55-61.

Phillips, R. L. 1996. Evaluation of 3 types of snares for capturing coyotes. Wildlife Society Bulletin 24: 107-110.

Phillips, R. L., and F. S. Blom. 1991. An evaluation of breakaway snares for use in coyote control. Proc. Midwest Furbear. Workshop 9:22.

Phillips, R. L., and K. S. Gruver. 1996. Performance of the Paws-I-Trip pan tension device on 3 types of traps. Wildlife Society Bulletin 24:119-122.

Phillips, R. L., and R. H. Schmidt. 1994. Fox. Pp C83-C88 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Phillips, R. L., F. S. Blom, and R. E. Johnson. 1990. An evaluation of breakaway snares for use in coyote control. Pages 255-259 *in* L. R. Davis and R. E. Marsh, eds., Proceedings of the 14th Vertebrate Pest Conference, University of California-Davis, Davis, California, USA.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273–288.

Pitelka, F. A. 1957. Some characteristics of microtine cycles in the artic. Oregon State College, Biological Colloquium Proceedings 18:73-88.

Pitt, W. C., F. F. Knowlton, and P. W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model: preliminary results. End. Spp. Update 18:103-106.

Pitt, W. C., P. W. Box, and F. F. Knowlton. 2003. An individual-based model of canid populations: modelling territoriality and social structure. Ecological Modelling 166:109-121.

Poessel, S. A., S. W. Breck, T. L. Teel, S. Shwiff, K. R. Crooks, and L. Angeloni. 2013. Patterns of human-coyote conflicts in the Denver Metropolitan Area. Journal of Wildlife Management 77:297-305.

Polis, G. A., C. A. Myers, and R. D. Holt. 1989. The ecology and evolution of intraguild predation: potential competitors that eat each other. Annual Review of Ecology and Systematics 20:297–330.

Prugh, L. R., C. J. Stoner, C. W. Epps, W. T. Bean, W. J. Ripple, A. S. Laliberte, and J. S. Brashares. 2009. The rise of the mesopredator. BioScience 59:779–791.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Minnesota. Journal of Wildlife Management 48:679-690.

Rashford, B. S., T. Foulke, and D. T. Taylor. 2010. Ranch-level economic impacts of predation in a range livestock system. Rangelands 32: 21-26.

Reidinger, R. F., and J. E. Miller. 2013. Wildlife damage management, prevention, problem solving and conflict resolution. The Johns Hopkins Press, Baltimore. 243 pp.

Reif, J. S. 1976. Seasonality, natality, and herd immunity in feline panleukopenia. Am. J. Epidemiology 103:81-87.

Riley S. P., D. J. Hadidian, and D. A. Manski. 1998. Population density, survival, and rabies in raccoons in an urban national park. Canadian Journal of Zoology 76:1153–1164.

Ripple, W. J., and R. L. Beschta. 2006*a*. Linking a cougar decline, trophic cascade, and catastrophic regime shift in Zion National Park. Biological Conservation 133:397–408.

Ripple, W. J., and R. L. Beschta. 2006*b*. Linking wolves to willows via risk-sensitive foraging by ungulates in the northern Yellowstone ecosystem. Forest Ecology and Management 230:96–106.

Ripple, W. J., A. J. Wirsing, C. C. Wilmers, and M. Letnic. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation 160:70-79.

Ripple, W. J., L. E. Painter, R. L. Beschta, and C. C. Gates. 2010. Wolves, elk, bison, and secondary trophic cascades in Yellowstone National Park. The Open Ecology Journal 3:31-37.

Ritcey, R. W., and R. Y. Edwards. 1956. Live trapping mink in British Columbia. Journal of Mammalogy 37:114-116.

Ritchie, E. G., and C. N. Johnson. 2009. Predator interactions, mesopredator release and biodiversity conservation. Ecology Letters 12:982–998.

Robel, R. J., A. D. Dayton, F. R. Henderson, R. L. Meduna, and C. W. Spaeth. 1981. Relationships between husbandry methods and sheep losses to canine predators. Journal of Wildlife Management 45:894-911.

Robinson, M. 1996. The potential for significant financial loss resulting from bird strikes in or around an airport. Proceedings of the Bird Strike Committee (Europe) 23:353-367.

Robinson, W. B. 1961. Population changes of carnivores in some coyote-control areas. Journal of Mammalogy 42:510–515.

Rolley, R. E., and W. D. Warde. 1985. Bobcat habitat use in southeastern Oklahoma. Journal of Wildlife Management 49:913-920.

Rosatte, R. C. 1987. Skunks. Pp 599-613 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Rosatte, R., and S. Lariviere. 2003. Skunks. Pp 692-707 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Ross, C. B., and J. Baron-Sorensen. 1998. Pet loss and human emotion: guiding clients through grief. Accelerated Development, Incorporation, Philadelphia, Pennsylvania, USA.

Rowley, G. J. and D. Rowley. 1987. Decoying coyotes with dogs. Proceedings of the Great Plains Wildlife Damage Conference Workshop 8:179-181.

Ruell, E. W., S. P. D. Riley, M. R. Douglas, J. P. Pollinger, and K. R. Crooks. 2009. Estimating bobcat population sizes and densities in a fragmented urban landscape using noninvasive capture-recapture sampling. Journal of Mammalogy 90:129–135.

Sacks, B., and J. Neale. 2002. Foraging strategy of a generalist predator toward special prey: Coyote predation on sheep. Ecological Applications 12:299-306.

Sacks, B., and J. Neale. 2007. Coyote abundance, sheep predation, and wild prey correlates illuminate Mediterranean trophic dynamics. Journal of Wildlife Management 71:2404-2411.

Samuel, M. D., and M. R. Fuller. 1996. Wildlife radiotelemetry. Pp 370-417 *in* Research and management techniques for wildlife and habitats, T. A. Bookhout, ed. Allan Press, Inc., Lawrence, Kansas.

Sanderson, G. C. 1987. Raccoons. Pp 486-499 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Schaefer, J. M., R. D. Andrews, and J. J. Dinsmore. 1981. An assessment of coyote and dog predation on sheep in southern Iowa. Journal of Wildlife Management 45:883-893.

Schauster, E. R., E. M. Gese, and A. M. Kitchen. 2002. Population ecology of swift foxes (*Vulpes velox*) in southeastern Colorado. Canadian Journal of Zoology 80:307-319.

Schmidt, R. H. 1989. Vertebrate pest control and animal welfare. Pages 63-68 *in* Vert. Pest Control and Manag. Materials. 6th Vol., ASTM STP 1055, K. A. Fagerstone and R. D. Curnow, eds., Amer. Soc. Material and Testing, Philadelphia, Pennsylvania, USA.

Schobert, E. 1987. Telazol use in wild and exotic animals. Veterinary Medicine 82:1080–1088.

Scott, M. D., and K. Causey. 1973. Ecology of feral dogs in Alabama. Journal of Wildlife Management 37:253-265.

Seidensticker, J., M. A. O’Connell, and A. J. T. Johnsingh. 1987. Virginia opossum. Pp 247-261 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Seidler, R. G., and E. M. Gese. 2012. Territory fidelity, space use, and survival rates of wild coyotes following surgical sterilization. Journal of Ethology 1-10.

Seidler, R. G., E. M. Gese, and M. M. Conner. 2014. Using sterilization to change predation rates of wild coyotes: A test case involving pronghorn fawns. Applied Animal Behaviour Science 154:83-92.

Sharp, T., and G. Saunders. 2008. A model for assessing the relative humaneness of pest animal control methods. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Sharp, T., and G. Saunders. 2011. A model for assessing the relatives humaneness of pest animal control methods. 2nd Edition. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Shelton, M. 2004. Predation and livestock production: Perspective and overview. Sheep and Goat Research Journal 19:2-5.

Shelton, M. and J. Klindt. 1974. The interrelationship of coyote density and certain livestock and game species in Texas. Texas Agricul. Exp. Station (MP-1148).

Shelton, M., and D. Wade. 1979. Predatory losses – a serious livestock problem. Animal Industry Today. Jan-Feb:4-9.

Shivik, J. A. 2006. Tools for the edge: What's new for conserving carnivores. BioScience 56:253-259.

Shivik, J. A., and D. J. Martin. 2001. Aversive and disruptive stimulus applications for managing predation. Pages 111-119 in M. C. Brittingham, J. Kays, and R. McPeake eds., Proceedings of the Ninth Wildlife Damage Management Conference. Pennsylvania State University, University Park, Pennsylvania, USA.

Shivik, J. A., A. Treves, and P. Callahan. 2003. Nonlethal techniques for managing predation: Primary and secondary repellents. Conservation Biology 17:1531-1537.

Shivik, J. A., L. Mastro, and J. K. Young. 2014. Animal attendance at M-44 sodium cyanide ejector sites for coyotes. Wildlife Society Bulletin 38:217-220.

Shwiff, S. A., and R. J. Merrell. 2004. Coyote predation management: an economic analysis of increased antelope recruitment and cattle production in south central Wyoming. Sheep and Goat Research Journal 19:29-33.

Slate, D. 1980. A study of New Jersey raccoon populations— determination of the densities, dynamics and incidence of disease in raccoon populations in New Jersey. New Jersey Division of Fish, Game and Wildlife, Pittman-Robertson Project W-52-R-8, Final Report.

Slate, D. A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Trans. N. A. Wildl. Nat. Res. Conf. 57:51-62.

Slater, M. R. 2004. Understanding issues and solutions for unowned, free-roaming cat populations. Journal of the American Veterinary Medical Association 225:1350-1354.

Sovada, M. A., C. C. Roy, J. B. Bright, and J. R. Gillis. 1998. Causes and rates of mortality of swift foxes in western Kansas. Journal of Wildlife Management 62:1300-1306.

Sovada, M. A., R. O. Woodward, and L. D. Igl. 2009. Historic range, current distribution, and conservation status of the swift fox, *Vulpes velox*, in North America. Canadian Field-Naturalist 123:346-367.

Speich, S. 1986. Colonial waterbirds. Pages 387-405 *in* A. Y. Cooperrider, R. J. Boyd, and H. R. Stuart, editors. Inventory and monitoring of wildlife habitat. USDI, Bureau of Land Management Service Center, Denver, Colorado, USA.

Stansley, W., L. Widjeskog, and D. E. Roscoe. 1992. Lead contamination and mobility in surface water at trap and skeet ranges. Bull. Environ. Contam. Toxicol. 49:640-647.

Stenseth, N. C., W. Falck, O. N. Bjornstad, and C. J. Kreb. 1997. Population regulation in snowshoe hare and Canadian lynx: Asymmetric food web configurations between hare and lynx. Proceedings of the National Academy of Sciences 94:5147-5152.

Sterner, R. T., and S. A. Shumake. 1978. Bait-induced prey aversion in predators: some methodological issues. Behav. Bio. 22:565-566.

Stevens, A. N. P. 2010. Dynamics of predation. Nature Education Knowledge 3(10):46.

Stoddart, L. C. 1984. Relationships between prey base fluctuations and coyote depredation on sheep on the Idaho National Engineering Laboratory (INEL), 1979-1982. Unpublished Research Work Unit Report. Denver Wildl. Res. Cent. 16 pp.

Stoddart, L. C., R. E. Griffiths, and F. F. Knowlton. 2001. Coyote responses to changing jackrabbit abundance affect sheep predation. Journal of Range Management 54:15-20.

Stoskopf, M. K., and F. B. Nutter. 2004. Analyzing approaches to feral cat management – one size does not fit all. Journal of the American Veterinary Medical Association 225:1361-1364.

Stoudt, J. H. 1982. Habitat use and productivity of canvasbacks in southwestern Manitoba, 1961-72. Pec. Sci. Rept. Wildl. 248. U.S. Fish and Wildlife Service. Washington, D.C. 31 pp.

Teutsch, S. M., D. D. Juranek, A. Sulzer, J. P. Dubey, and R. K. Sikes. 1979. Epidemic toxoplasmosis associated with infected cats. N. Engl. J. Med. 300:695-699.

The Wildlife Society. 2015. Standing position statement: wildlife damage management. The Wildlife Society, Washington., D.C. 2 pp.

Thompson, B. C. 1979. Evaluation of wire fences for coyote control. Journal of range management 32:457-461.

Thorpe, J. 1996. Fatalities and destroyed civil aircraft due to bird strikes, 1912-1995. Proceedings of Bird Strike Committee Europe 23:17-32.

Thorpe, J. 1997. The implications of recent serious bird strike accidents and multiple engine ingestions. Bird Strike Committee USA, Boston, Massachusetts.

Tigner, J. R., and G. E. Larson. 1977. Sheep losses on selected ranches in southern Wyoming. Journal of Range Management 30:244-252.

Till J. A. 1992. Behavioral effects of removal of coyote pups from dens. Proceedings of the Vertebrate Pest Conference 15:396-399.

Till, J. A., and F. F. Knowlton. 1983. Efficacy of denning in alleviating coyote depredations upon domestic sheep. Journal of Wildlife Management 47:1018-1025.

Timm, R. M., Baker, R. O., Bennett, J. R. and Coolahan, C. C. 2004. Coyote attacks: an increasing urban problem. Proceedings of the 69th North American Wildlife and Natural Resources Conference, March 16-20, 2004, Spokane, Washington.

Trapp, G. R. 1978. Comparative behavioral ecology of the ringtail (*Bassariscus astutu*s) and gray fox (*Urocyon cinereoargenteu*s) in southwestern Utah. Carnivore 1:3–32.

Treves, A., and L. Naughton-Treves. 2005. Evaluating lethal control in the management of human-wildlife conflict. Pp. 86-106 in R. Woodroffe, S. Thirgood, A. Rabinowitz, eds. People and Wildlife: Conflict or Coexistence. University of Cambridge Press, United Kingdom.

Treves, A., M. Krofel, and J. McManus. 2016. Predator control should not be a shot in the dark. Frontiers in Ecology and the Environment 14:380-388.

Truyen U., D. Addie, S. Belák, C. Boucraut-Baralon, H. Egberink, T. Frymus, T. Gruffydd-Jones, K. Hartmann, M.J. Hosie, A. Lloret, H. Lutz, F. Marsilio, M.G. Pennisi, A.D. Radford, E. Thiry, and M.C. Horzinek. 2009. Feline panleukopenia. ABCD guidelines on prevention and management. J. Feline Med. Surg. 11:538-46.

Twichell, A. R., and H. H. Dill. 1949. One hundred raccoons from one hundred and two acres. Journal of Mammalogy 30:130–133.

United States Census Bureau. 2010. 2010 census state area measurements and internal point coordinates. http://www.census.gov/geo/www/2010census/statearea_intpt.html. Accessed January 10, 2012.

USDA. 2012. Neospora caninum. National Wildlife Disease Program Annual Report 2011. 62 pp.

USDA. 2014. Oklahoma state and county data. 2012 Census of Agriculture, Volume 1, Geographic Area Series, Part 36. AC-12-A-36. 663 pp.

USDA. 2015*a*. Environmental Assessment: Aquatic rodent damage management in Oklahoma. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Oklahoma City, Oklahoma. 128 pp.

USDA. 2015*b*. Final Environmental Impact Statement: Feral swine damage management: A national approach. USDA/APHIS/WS, Riverdale, Maryland, USA.

United States Department of Justice. 2014. Two sentenced for violating Eagle Protection Act. United States Department of Justice, United States Attorney's Office, Western District of Wisconsin.

United States Department of Justice. 2015. Farmer sentenced for poisoning bald eagles. United States Department of Justice, United States Attorney's Office, Western District of New York.

USFWS and the United States Department of Commerce. 2011. 2011 National survey of fishing, hunting, and wildlife-associated recreation. 172 pp.

United States Forest Service. 1992. Overview, Report to Congress, Potential Impacts of Aircraft Overflights of National Forest System Wilderness. Report to Congress. Prepared pursuant to Section 5, Public Law 100-91, National Park Overflights Act of 1987.

United States Forest Service. 2003. Final Environmental Impact Statement for the Revised Land and Resource Management Plan-Medicine Bow National Forest. United States Department of Agriculture, United States Forest Service, Rocky Mountain Region.

United States General Accounting Office. 1990. Wildlife Management: Effects of Animal Damage Control Program on Predators. U.S. GAO Report to the Hon. Alan Cranston, U.S. Senate. GAO/RCED-90-149. 31 pp.

United States General Accounting Office. 2001. Wildlife Services Program: Information on activities to manage wildlife damage. Report to Congressional Committees. GOA-02-138. 71 pp.

United States Geological Survey. 1996. National water summary on wetland resources. United States Geological Survey Water-Supply Paper 2425. 444 pp.

VanDruff , L. W. 1971. The ecology of the raccoon and opossum, with emphasis on their role as waterfowl nest predators. Ph.D. Thesis. Cornell University, Ithaca, New York. 140 pp.

VerCauteren, K. C., M. J. Lavelle, T. M. Gehring, and J. Landry. 2012. Cow dogs: Use of livestock protection dogs for reducing predation and transmission of pathogens from wildlife to cattle. Applied Animal Behaviour Science 140:128-136.

Verts, B. J. 1963. Movements and populations of opossums in a cultivated area. Journal of Wildlife Management 27:127129.

Vincent, C. H., L. A. Hanson, and J. P. Bjelopera. 2014. Federal land ownership: Overview and data. Congressional Research Service. 28 pp.

Virchow, D. and D. Hogeland. 1994. Bobcats. Pp C35-C45 *in* S.E. Hygnstrom, R.M. Timm and G.E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Voigt, D. R. 1987. Red fox. Pp 378-392 *in* M. Novak, J. A. Baker, M.E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Voigt, D. R., and W. E. Berg. 1987. Coyote. Pp 345-357 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management 47:852–857.

Voigt, D. R., and D. W. MacDonald. 1984. Variation in the spatial and social behavior of the red fox, *Vulpes vulpes.* Acta Zoologica Fennica 171:261-265.

Voigt, D. R., and R. L. Tinline. 1980. Strategies for analyzing radio tracking data. Pp 387–404 *in* C. J. Amlaner, Jr., and D. W. MacDonald, eds. A handbook on biotelemetry and radio tracking. Pergamon Press, Oxford, United Kingdom.

Wagner, F. H. 1988. Predator control and the sheep industry. Regina Books, Claremont, California, USA.

Wagner, F. H., and L. C. Stoddart. 1972. Influence of coyote predation on black-tailed jackrabbit populations in Utah. Journal of Wildlife Management 36:329–342.

Wagner, K. K. 1997. Preventive predation management: an evaluation using winter aerial coyote hunting in Utah and Idaho. Ph.D. Thesis. Utah St. University, Logan, Utah.

Wagner, K. K. and M. R. Conover. 1999. Effect of preventive coyote hunting on sheep losses to coyote predation. Journal of Wildlife Management 63:606-612.

Wallace, L. A.. 1987. Total Exposure Assessment Methodology (TEAM) Study: Summary and Analysis, Volume I, Final Report. EPA/600/6-87/002a. Washington, D.C.

Wallach, A. D., C. N. Johnson, E. G. Ritchie, and A. J. O'Neill. 2010. Predator control promotes invasive dominated ecological states. Ecology Letters 13:1008–1018.

Waser, N. M., M. V. Price, D. T. Blumstein, S. R. Arozqueta, B. D. C. Escobar, R. Pickens, and A. Pistoia. 2014. Coyotes, deer, and wildflowers: Diverse evidence points to a trophic cascade. Naturwissenschaften 101:427–436.

Weisenberger, M. E., P. R. Krausman, M. C. Wallace, D. W. De Young, and O. E. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. Journal of Wildlife Management 60:52-61.

Weisman, A. D. 1991. Bereavement and companion animals. Omega: Journal of Death and Dying 22: 241-248.

Westman, W. E. 1978. Measuring the inertia and resilience of ecosystems. BioScience 28:705–710.

Whisson, D. A., G. J. Holland, and K. Carylon. 2012. Translocation of overabundant species: implication for translocated individuals. Journal of Wildlife Management 76:1661-1669.

Whitaker, Jr., J. O., and W. L. J. Hamilton, Jr. 1998. Mammals of the Eastern United States. Cornell University Press, Ithaca, New York. 583 pp.

White, C. M., and S. K. Sherrod. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor surveys. Raptor Research 7:97-104.

White, C. M., and T. L. Thurow. 1985. Reproduction of Ferruginous Hawks exposed to controlled disturbance. Condor 87:14-22.

Windberg, L.A., and F. F. Knowlton. 1988. Management implications of coyote spacing patterns in southern Texas. Journal of Wildlife Management 52:632-640.

Williams, C. L., K. Blejwas, J. J. Johnston, and M. M. Jaeger. 2003. Temporal genetic variation in a coyote (*Canis latrans*) population experiencing high turnover. Journal of Mammalogy 84:177-184.

Winter. 2004. Trap-neuter-release programs: The reality and the impacts. Journal of the American Veterinary Medical Association 225:1369-1376.

Wiseman G. L., and G. O. Hendrickson. 1950. Notes on the life history of the opossum in southeast Iowa. Journal of Mammalogy 31:331-337.

Witmer, G. W., J. L. Bucknall, T. H. Fritts, and D. G. Moreno. 1996. Predator management to protect endangered avian species. Trans. 61st No. Amer. Wildl. And Natur. Resourc. Conf. 61:102-108.

Woolington, J. D. 1984. Habitat use and movements of river otters at Kelp Bay, Baranof Island, Alaska. M.S. Thesis, University of Alaska, Fairbanks, Alaska.

Wywialowski, A. P. 1994. Agricultural producers' perceptions of wildlife-caused losses. Wildlife Society Bulletin 22: 370-382.

Yeager, L. E., and R. G. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois River bottom lands. Journal of Wildlife Management 7:45–60.

Young, J. K., E. Miller, and A. Essex. 2015. Evaluating fladry designs to improve utility as a nonlethal management tool to reduce livestock predation. Wildlife Society Bulletin 39:429-433.

Young, J. K., K. A. Olson, R. P. Reading, S. Amgalanbaatar, and J. Berger. 2011. Impacts of feral and free-roaming dogs on wildlife populations. BioScience 61:125-132.

Zasloff, R. L. 1996. Human-animal interactions. Special Issue. Applied Animal Behaviour Science. 47: 43-48.

APPENDIX B

METHODS AVAILABLE FOR RESOLVING OR PREVENTING PREDATOR DAMAGE

The most effective approach to resolving wildlife damage problems would be to integrate the use of several methods, either simultaneously or sequentially. An adaptive plan would integrate and apply practical methods of prevention and reduce damage by predators while minimizing harmful effects of damage reduction measures on people, other species, and the environment. An adaptive plan may incorporate resource management, physical exclusion and deterrents, and population management, or any combination of these, depending on the characteristics of specific damage problems.

In selecting damage management techniques for specific damage situations, consideration would be given to the responsible species and the magnitude, geographic extent, duration and frequency, and likelihood of wildlife damage. Consideration would also be given to the status of target and potential non-target species, local environmental conditions and impacts, social and legal aspects, and relative costs of damage reduction options. The cost of damage reduction may sometimes be a secondary concern because of the overriding environmental, legal, and animal welfare considerations. Those factors would be evaluated in formulating damage management strategies that incorporate the application of one or more techniques.

A variety of methods would potentially be available to the WS program in Oklahoma relative to the management or reduction of damage from predators. Various federal, state, and local statutes and regulations and WS directives would govern WS' use of damage management methods. WS would develop and recommend or implement strategies based on resource management, physical exclusion, and wildlife management approaches. Within each approach there may be available a number of specific methods or techniques. The following methods could be recommended or used by the WS program in Oklahoma. Many of the methods described would also be available to other entities in the absence of any involvement by WS. When the WS program receives a request for assistance, personnel consider the range of limitations as they apply the WS decision-making process described in Slate et al. (1992) and WS Directive 2.201 to determine what method(s) to use to resolve a wildlife damage problem.

Non-chemical Wildlife Damage Management Methods

Non-chemical management methods consist primarily of tools or devices used to repel, capture, or kill a particular animal or local population of wildlife to alleviate damage and conflicts. Methods may be non-lethal (*e.g.*, fencing, frightening devices) or lethal (*e.g.*, firearms, body grip traps). If WS' personnel apply those methods, a MOU, work initiation document, or another similar document must be signed by the landowner or administrator authorizing the use of each damage management method. Non-chemical methods used or recommended by WS could include:

Exclusion pertains to preventing access to resources through fencing or other barriers. Fencing can sometimes prevent animals that cannot climb from entering areas of protected resources. Fencing installed with an underground skirt can prevent access to areas for many predator species that dig, including coyotes, fox, feral dogs, feral cats, and striped skunks. Areas such as airports, yards, or gardens may be fenced using either electric or non-electric fencing. Hardware cloth or other metal barriers can sometimes be used to prevent the entry of smaller predators, like skunks and raccoons, into buildings through existing holes or gaps.

Fences are widely used to prevent damage from predators. Exclusionary fences constructed of woven wire or multiple strands of electrified wire can be effective in keeping predators from some areas such as a sheep pasture or an airport. For example, Matchett et al. (2013) found that electronet could exclude coyotes from black-tailed prairie dog (*Cynomys ludovicianus*) colonies. The size of the wire grid and height of the fence must be able to keep the predators out. In addition, an underground apron (*e.g.*, fencing in the shape of an "*L*" going outward) about 2 feet down and 2 feet out helps make a fence more wildlife proof; the "*L*" keeps predators out that dig crawl holes under the fence. However, fencing has limitations. Even an electrified fence is not always wildlife-proof and the expense of the fencing can often exceed the benefit. In addition, if large areas are fenced, the wildlife being excluded has to be removed from the enclosed area to make it useful. Some fences inadvertently trap, catch or affect the movement of non-target wildlife and may not be practical or legal in some areas (*e.g.*, restricting access to public land).

Cultural Methods includes the application of practices that seek to minimize exposure of the protected resource to damaging animals through processes other than exclusion. They may include animal husbandry practices, such as employing guard dogs, herders, shed lambing, carcass removal, or pasture selection. Strategies may also include minimizing cover where damaging predators might hide, manipulating the surrounding environment through barriers or fences to deter animals from entering a protected area. Removal of trees from around buildings can sometimes reduce damage associated with raccoons.

For example, WS may talk with residents of an area to eliminate the feeding of wildlife that occurs in parks, recreational sites, or residential areas to reduce damage by certain predators, such as coyotes or raccoons. Some predators that cause damage in urban environments are attracted to homes by the presence of garbage or pet food left outside and unprotected. Removal or sealing of garbage in tight trash receptacles, and elimination of all pet foods from outside areas can reduce the presence of unwanted animals. However, many people who are not directly affected by problems caused by wildlife enjoy wild animals and engage in activities that encourage their presence.

Another example of human behavior modification consists of assisting people that have a fear of an animal. WS receives calls about species, such as coyotes, that are not causing damage. Their mere presence is perceived as a threat to the callers even though the animal is in its natural habitat. Personnel of WS provide educational information and reassurance about these species.

Guard Animals are used in damage management to protect a variety of resources, primarily livestock, and can provide adequate protection at times (Andelt 2004, Gehring et al. 2010*a*, VerCauteren et al. 2012). Gehring et al. (2010*b*) provides a historically overview of the use of guard animals to protect livestock from predation. Guard animals (*e.g.*, dogs, burros, and llamas) have proven successful in many sheep and goat operations. The effectiveness of guarding animals may not be sufficient in areas where there is a high density of wildlife to be deterred, where the resource (*e.g.*, sheep foraging on open range) is widely scattered, or where the guard animal to resource ratios are less than recommended. WS Directive 2.440 provides guidelines for the activities of WS' personnel relating to the use of livestock guarding dogs for protecting livestock from predation. All WS' field personnel will be knowledgeable in the use and application of livestock guarding dogs and will assist producers who may be interested in using livestock guarding dogs by providing information and/or referring them to other WS' personnel for further assistance. WS was instrumental in the introduction and adoption of livestock guarding dogs in the late 1980s and early 1990s and continues to recommend use of livestock guarding dogs where appropriate (Green and Woodruff 1983, Green and Woodruff 1988). The NWRC continues to conduct research into new breeds of livestock guarding dogs (Marlow 2016).

Habitat Management would involve localized manipulation of habitats to minimize the presence of predators. Localized habitat management is often an integral part of damage management. The type, quality, and quantity of habitat are directly related to the wildlife produced or attracted to an area. Habitat can be managed to not produce or attract certain wildlife species. Habitat management is typically aimed at eliminating cover used by particular predators at specific sites. Limitations of habitat management as a method of reducing predator damage are determined by the characteristics of the species involved, the nature of the damage, economic feasibility, and other factors. Legal constraints may also exist that preclude altering particular habitats.

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

Animal behavior modification refers to tactics that deter or repel damaging predators and thus, reduce damage to the protected resource. Those techniques are usually aimed at causing target animals to respond by fleeing from the site or remaining at a distance. They usually employ extreme noise or visual stimuli. Unfortunately, many of these techniques are only effective for a short time before wildlife habituate to them (Conover 1982, Mitchell et al. 2004). Devices used to modify behavior in predators include fladry (Mettler and Shivik 2007, Young et al. 2015), electronic guards (siren strobe-light devices) (Linhart et al. 1992), propane exploders, pyrotechnics, laser lights, human effigies, and the noise associated with the discharge of a firearm.

The success of frightening methods depends on an animal's fear of, and subsequent aversion to, offensive stimuli (Shivik and Martin 2001, Shivik et al. 2003, Mettler and Shivik 2007). A persistent effort is usually required to effectively apply frightening techniques and the techniques must be sufficiently varied to prolong their effectiveness. Over time, animals often habituate to commonly used scare tactics and ignore them (*e.g.*, see Dolbeer et al. 1986, Bomford 1990, Shivik et al. 2003, Mitchell et al. 2004, Shivik 2006). In addition, in many cases, animals frightened from one location become a problem at another. Scaring devices, for the most part, are directed at specific target species and operated by private individuals or personnel of WS working in the field. However, several of these devices, such as scarecrows and propane exploders, are automated.

Harassment and other methods to frighten animals are probably the oldest methods of combating wildlife damage. These devices may be either auditory or visual and provide short-term relief from damage. A number of sophisticated techniques have been developed to scare or harass wildlife from an area. The use of noise-making devices (*e.g.*, electronic distress sounds, propane cannons, and pyrotechnics) is the most popular. Other methods include harassment with visual stimuli (*e.g.*, flashing or bright lights, scarecrows, human effigies), vehicles, or people. Some methods such as the electronic guard use a combination of stimuli (siren and strobe light). These are used to frighten predators from the immediate vicinity of the damage prone area. As with other damage management efforts, these techniques tend to be more effective when used collectively in a varied regime rather than individually. However, the continued success of these methods frequently requires reinforcement by limited shooting or other local population reduction methods.

Live Capture and Translocation can be accomplished using hand capture, catch poles, cage traps, some cable devices, or with foothold traps to capture predators for the purpose of translocating them for release in other areas. WS could employ those methods in Oklahoma when the target animal(s) can legally be translocated or can be captured and handled with relative safety by WS' personnel. Live capture and handling of predators poses an additional level of human health and safety threat if predators are aggressive or extremely sensitive to the close proximity of people. For that reason, WS may limit this method to specific situations. In addition, moving damage-causing individuals to other locations can typically result in damage at the new location, or the translocated individuals can move from the relocation site to areas where they are unwanted. Although translocation is not necessarily precluded in all cases, it would be logistically impractical, in most cases, and biologically unwise in Oklahoma due to the risk of disease transmission. High population densities of some animals may make this a poor wildlife management strategy for those species. Translocation would be evaluated by WS on a case-by-case basis. Translocation would only occur with the prior authorization of the ODWC.

Trapping can utilize a number of devices, including foothold traps, cage-type traps, and body-gripping traps, foot snares, and neck/body snares. Trapping methods would be available to all entities under the alternatives.

Foothold Traps can be effectively used to capture a variety of animals. Foothold traps can be placed beside, or in some situations, in travel ways being actively used by the target species. Placement of traps is contingent upon the habits of the respective target species, habitat conditions, and presence of non-target animals. Effective trap placement and adjustment and the use and placement of appropriate baits and lures by trained WS' personnel also contribute to the selectivity of foothold traps. An additional advantage is that foothold traps can allow for the on-site release of non-target animals since animals are captured alive. The use of foothold traps requires more skill than some methods. Foothold traps would generally be available for use by the public and other state or federal agencies.

Cable devices are typically made of single or multi-strand cable, and can be set to capture an animal by the neck, body, and foot. They can be used effectively to catch most species, but are most frequently used to capture coyotes, fox, and mountain lions. Cable devices are much lighter and easier to use than other methods and are not generally affected by inclement weather. Cable devices may be used as either lethal or live-capture devices depending on how or where they are set. Cable devices set to capture an animal by the neck are usually lethal but stops can be attached to the cable to increase the probability of a live capture depending on the trap check interval. Cable devices positioned to capture the animal around the body can be a useful live-capture device, but are more often used as a lethal control technique. Cable devices can incorporate a breakaway feature to release non-target wildlife and livestock where the target animal is smaller than potential non-target animals (Phillips et al. 1990, Phillips 1996). Cable devices can be effectively used wherever a target animal moves through a restricted travel lane (*e.g.*, under fences or trails through vegetation). When an animal moves forward into the loop formed by the cable, the noose tightens and the animal is held. Cable devices must be set in locations where the likelihood of capturing non-target animals is minimized.

The foot or leg snare can be set as a spring-powered non-lethal device, activated when an animal places its foot on the trigger or pan. In some situations, using snares to capture wildlife is impractical due to the behavior or morphology of the animal, or the location of many wildlife conflicts. Foot snares are used effectively to capture large predators, such as mountain lions. Additionally, several foot snare designs have been developed to capture smaller predators such as coyotes and bobcats. In general, cable devices would be available to all entities to alleviate damage.

Body-grip Traps are designed to cause the quick death of the animal that activates the trap. Body-grip traps are not often used during predator damage management, except for smaller predators (*e.g.*, raccoons, skunks, and mink). Body-grip traps have a pair of square, rotating jaws that when activated typically strike an animal at neck and throat areas. WS policy prohibits the use of body-grip traps with a jaw spread exceeding 8 inches for land sets.

Cage traps come in a variety of styles to live-capture animals. The most commonly known cage traps are box traps. Box traps are usually rectangular and are made from various materials, including metal, wire mesh, or plastic. These traps are used to capture animals alive and can often be used where many lethal tools were impractical. These traps are well suited for use in residential areas and work best when baited with foods attractive to the target animal. Box traps are generally portable and easy to set-up.

Cage traps have some disadvantages. Some individual target animals may avoid cage traps (*i.e.*, become trap shy). Some non-target animals may associate the traps with available food and they purposely enter the traps to eat the bait, making the trap unavailable to catch target animals. Cage traps must be checked frequently to ensure that captured animals are not subjected to extreme environmental conditions. Some animals will fight to escape, which may cause injuries to the animal. Cage traps can be expense to purchase.

Trap monitors are devices that send a radio signal to a receiver if a set trap is disturbed and alerts field personnel that an animal may be captured. Trap monitors can be attached directly to the trap or attached to a string or wire and then placed away from the trap in a tree or shrub. When the monitor is hung above the ground, it can be detected from several miles away, depending on the terrain in the area. 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.

Trap monitoring devices would be employed, when applicable, that indicate when a trap has been activated. Trap monitoring devices would allow personnel to prioritize trap checks and decrease the amount of time required to check traps, which decreases the amount of time captured target or non-targets would be restrained. By reducing the amount of time targets and non-targets are restrained, pain and stress can be minimized and captured wildlife can be addressed in a timely manner, which could allow non-targets to be released unharmed. Trap monitoring devices could be employed where applicable to facilitate monitoring of the status of traps in remote locations to ensure any captured wildlife was removed promptly to minimize distress and to increase the likelihood non-targets could be released unharmed.

Denning is the practice of locating coyote or fox dens and lethally removing the young, adults or both to stop an ongoing predation problem or prevent future depredation of livestock. Denning is used in coyote and fox damage management, but is limited because dens are often difficult to locate and den use by the target animal is restricted to about 2 to 3 months during the spring. Coyote depredations on livestock and poultry often increase in the spring and early summer due to the increased food requirements associated with feeding and rearing litters of pups (Till and Knowlton 1983, Till 1992). Removal of pups will often stop depredations even if the adults are not taken (Till 1992). When the adults are taken at or near a known den location, it is customary to euthanize the pups to prevent their starvation because they would be unable to survive on their own. Pups are typically euthanized by digging out the den and euthanizing the pups with sodium pentobarbital (see discussion of sodium pentobarbital). Denning is labor intensive with no guarantee of finding the den of the target animal. Denning is very target-specific and is most often used in open terrain where dens are comparatively easy to find.

Harvest during the Hunting/Trapping Season is sometimes recommended by WS to resource owners. WS could recommend resource owners consider legal hunting/trapping as an option for reducing predator damage. Although legal hunting/trapping is impractical and/or prohibited in many urban-suburban areas, it can be used to reduce some local populations of predators.

Shooting with firearms is very selective for the target species and would be conducted with rifles, handguns, and shotguns. Methods and approaches used by WS may include use of vehicles or aircraft, illuminating devices, bait, decoy dogs, predator calls, firearm suppressors, night vision/thermal equipment, and elevated platforms. Shooting is an effective method in some circumstances, and can often provide immediate relief from the problem. Shooting may at times be one of the only methods available to effectively and efficiently resolve a wildlife problem.

Ground shooting is sometimes used as the primary method to alleviate damage or threats of damage. Shooting predators is frequently performed in conjunction with calling, particularly for coyotes. Vocal calls, handheld mouth-blown calls, and electronic calls could be used to mimic target species (*e.g*., coyote howls and raccoons fighting) or prey (*e.g*., injured jackrabbit and chicken) vocalizations. Shooting would be limited to locations where it is legal and safe to discharge a weapon. A shooting program, especially conducted alone, can be expensive because it often requires many staff hours to complete.

Shooting can also be used in conjunction with an illumination device at night, which is especially useful for nocturnal animals, such as coyotes. Spotlights may or may not be 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, and is often the preferred equipment due to the ability to detect and identify animals in complete darkness. Night vision and FLIR equipment aid in locating animals at night when animals may be more active. Night vision and FLIR equipment could be used during surveys and in combination with shooting to remove target animals at night. WS' personnel most often use this technology to target animals in the act of causing damage or likely responsible for causing damage. Those methods aid in the use of other methods or allow other methods to be applied more selectively and efficiently. Night vision and FLIR equipment allow for the identification of target species during night activities, which reduces the risks to non-targets and reduces human safety risks. Night vision equipment and FLIR devices only aid in the identification of animals and are not actual methods of lethal removal. The use of FLIR and night vision equipment to remove target animals would increase the selectivity of direct management activities by targeting those animals most likely responsible for causing damage or posing threats.

Aerial Shooting (*i.e*., shooting from an aircraft) is a commonly used damage management method for coyotes. Aerial shooting can be especially effective in removing offending coyotes that have become "*bait-shy*" to trap sets or are not susceptible to calling and shooting. Aerial shooting consists of visually sighting target animals in the problem area and personnel shooting the animal from the aircraft. Local depredation problems (*e.g*., calf predation by coyotes) can often be resolved quickly through aerial shooting. Aerial shooting is mostly species-selective (there is a slight potential for misidentification) and can be used for immediate control to reduce livestock and natural resource losses if weather, terrain, and cover conditions are favorable. Fixed-wing aircraft are most frequently used in flat and gently rolling terrain whereas helicopters with better maneuverability have greater utility and are safer over brush covered ground, timbered areas, steep terrain, or broken land where animals are more difficult to spot.

Cain et al. (1972) rated aerial shooting as "*very good*" in effectiveness for problem solving, safety, and lack of adverse environmental impacts. Connolly and O'Gara (1987) documented the efficacy of aerial shooting in taking confirmed sheep-killing coyotes. Wagner (1997) and Wagner and Conover (1999) found that aerial shooting might be an especially appropriate tool as it reduces risks to non-target animals and minimizes contact between damage management operations and recreationists. They also stated that aerial shooting was an effective method for reducing livestock predation and that aerial hunting 3 to 6 months before sheep are grazed on an area was cost-effective when compared with areas without aerial hunting.

Good visibility and relatively clear and stable weather conditions are required for effective and safe aerial shooting. Summer conditions limit the effectiveness of aerial shooting as heat reduces coyote activity and visibility is greatly hampered by vegetative ground cover. Air temperature (high temperatures), which influences air density affects low-level flight safety and may restrict aerial shooting activities. In broken timber or deciduous cover, aerial shooting is more effective in winter when the leaves have fallen or in early spring before the leaves emerge, which improves visibility. The WS program aircraft-use policy helps ensure that aerial shooting is conducted in a safe and environmentally sound manner, in accordance with federal and state laws. Pilots and aircraft must be certified under established WS program procedures and only properly trained WS' employees are approved as gunners. Ground crews are often used with aerial operations for safety reasons. Ground crews can also assist with locating and recovering target animals, as necessary.

Aircraft overflights have created concerns about disturbing wildlife. The National Park Service (1995) reviewed studies on the effects of aircraft overflights on wildlife. Their report revealed that a number of studies documented responses by certain wildlife species that could suggest adverse impacts may occur. Few, if any studies, have proven that aircraft overflights cause significant adverse impacts to wildlife populations, although the report stated it is possible to draw the conclusion that affects to populations could occur. It appears that some species will frequently, or at least occasionally, show adverse responses to even minor overflight occurrences. In general, it appears that the more serious potential impacts occur when overflights are frequent, such as hourly, and over long periods of time, which represents chronic exposure. Chronic exposure situations generally occur in areas near commercial airports and military flight training facilities. The use of firearms from aircraft would occur in remote areas where tree cover and vegetation allows for visibility of target animals from the air. WS spends relatively little time over any one area.

WS has used fixed-wing aircraft and helicopters for aerial shooting in areas inhabited by wildlife for years. WS conducts aerial activities on areas only under signed agreement and concentrates efforts during certain times of the year and to specific areas. WS flies very little over any one property under agreement in any given year. As a result, no known problems to date have occurred with WS' aerial shooting overflights on wildlife, nor are they anticipated in the future.

Aerial Surveying is a commonly used tool for evaluating and monitoring damage and establishing population estimates and locations of various species of wildlife. WS uses aerial surveying throughout the United States to monitor damages and/or populations of coyotes, fox, wolves, feral swine, feral goats, feral dogs, bobcats, mountain lions, white-tailed deer, pronghorn antelope, elk, big-horn sheep, and wild horses but any wildlife species big enough to see from a moving aircraft could be surveyed using this method. As with aerial shooting, the WS program aircraft-use policy helps ensure that aerial surveys are conducted in a safe and environmentally sound manner, in accordance with federal and state laws. Pilots and aircraft must also be certified under established WS program procedures and policies.

Aerial Telemetry is used in research projects studying the movements of various wildlife species. Biologists will frequently place radio-transmitting collars on selected individuals of a species and then monitor their movements over a specified period. Whenever possible, the biologist attempts to locate the research subject using a hand-held antennae and radio receiver, however, occasionally animals will make large movements that prevent biologists from locating the animal from the ground. In these situations, WS can utilize either fixed wing aircraft or helicopters and elevation to conduct aerial telemetry and locate the specific animal wherever it has moved to. As with any aerial operations, the WS program aircraft-use policy helps ensure that aerial surveys would be conducted in a safe and environmentally sound manner, in accordance with federal and state laws.

Trained Dogs are frequently used in predator damage management to locate, pursue, or decoy animals. The WS program could use trailing/tracking, decoy, and trap-line companion dogs. Training and maintaining suitable dogs requires considerable skill, effort, and expense. WS Directive 2.445 establishes standards and responsibilities for WS' use of trained dogs to assist in accomplishing activities. When using trained dogs, WS' personnel would adhere to WS Directive 2.445.

Tracking Dogs or trailing dogs are commonly used to track and "*tree*" target wildlife species, such as mountain lions, bobcats, and raccoons. Although not as common, they sometimes are trained to track coyotes (Rowley and Rowley 1987, Coolahan 1990). Dogs commonly used are different breeds of hounds, such as blue tick, red-bone, and Walker. They become familiar with the scent of the animal they are to track and follow, and the dogs strike (howl) when they detect the scent. Tracking dogs are trained not to follow the scent of non-target species. Personnel of WS typically find the track of the target species at fresh kills or drive through the area of a kill site until the dogs strike. Personnel would then put their dogs on the tracks of the target predator. Typically, if the track is not too old, the dogs can follow the trail and tree the animal. The animal usually seeks refuge up a tree, in a thicket on the ground, on rocks or a cliff, or in a hole. The dogs stay with the animal until personnel arrive and dispatch, tranquilize, or release the animal, depending on the situation. A possibility exists that dogs could switch to a fresher trail of a non-target species while pursuing the target species. This could occur with any animal that they have been trained to follow, and could occur with an animal that is similar to the target species. For example, dogs on the trail of a mountain lion could switch to a bobcat, if they cross a fresher track. With this said, this risk can be minimized greatly by the personnel of the WS looking at the track prior to releasing the dogs and calling them off a track if it is determined that they have switched tracks.

Decoy Dogs are primarily used in coyote damage management in conjunction with calling. Dogs are trained to spot and lure coyotes into close shooting range for personnel of WS. Decoy dogs are especially effective for territorial pairs of coyotes. Decoy dogs are typically medium-sized breeds that are trained to stay relatively close to personnel.

Trap-line Companion Dogs could accompany personnel of WS in the field while they were setting and checking equipment. They would be especially effective in finding sites to set equipment by alerting their owners to areas where coyotes or other predators have traveled, urinated, or defecated, which are often good sites to make sets. Trap-line companion dogs stay with personnel and most always have no effect on non-target animals. Trap-line dogs may increase the selectivity towards territorial coyotes by identifying territorial canine scent locations.

Chemical Wildlife Damage Management Methods

The EPA through the FIFRA, the ODAFF, the United States Drug Enforcement Administration, MOUs with land managing agencies, and WS' directives would regulate chemical methods that could be available for use by WS pursuant to the alternatives (see WS Directive 2.401, WS Directive 2.405, WS Directive 2.430, WS Directive 2.465). All pesticides used by WS would be registered under the FIFRA and administered by the EPA and the ODAFF. All WS' personnel in Oklahoma who apply restricted-use pesticides would be certified pesticide applicators by the ODAFF and have specific training by WS for pesticide application. The EPA and the ODAFF require pesticide applicators to adhere to all certification requirements set forth in the FIFRA. Pharmaceutical drugs, including those used in wildlife capture and handling, are administrated by the United States Food and Drug Administration and/or the United States Drug Enforcement Administration. Employees of WS that use immobilizing drugs and euthanasia chemicals would be certified for their use and follow the guidelines established in the WS Field Operational Manual for the Use of Immobilization and Euthanasia Drugs (Johnson et al. 2001).

Chemicals would not be used by WS on public or private lands without authorization from the land management agency or property owner or manager. Under certain circumstances, personnel of WS could be involved in the capture of animals where the safety of the animal, personnel, or the public could be compromised and chemical immobilization would provide a good solution to reduce those risks. For example, chemical immobilization could be used to capture coyotes where public safety was at risk. Immobilizing drugs are most often used by WS to remove animals from cage traps to be examined (*e.g.*, for disease surveillance) or in areas such as urban, recreational, and residential areas where the safe removal of a problem animal is most easily accomplished with a drug delivery system (*e.g.*, darts from rifle). Immobilization is usually followed by release (*e.g.*, after radio collaring a coyote for a study), translocation, or euthanasia. Chemically euthanized animals would be disposed of by incineration or deep burial to avoid secondary hazards. Immobilizing drugs and euthanasia chemicals would be monitored closely and stored in locked boxes or cabinets according to WS' policies and United States Drug Enforcement Administration guidelines. Most drugs fall under restricted-use categories and must be used under the appropriate license from the United States Drug Enforcement Administration. The following chemical methods have been proven to be selective and effective in reducing damage by predators.

Chemical Immobilization Drugs

Ketamine (Ketamine HCl) is a fast acting dissociative anesthetic (*i.e.*, loss of sensation with or without loss of consciousness) that is used to capture animals. Ketamine produces catatonia (*i.e.*, lack of movement, activity, or expression) and profound analgesia (*i.e.*, insensibility to pain without loss of consciousness), but not muscle relaxation. It is used to eliminate pain, calm fear, and allay anxiety. Ketamine is possibly the most versatile drug for chemical capture, and it has a wide safety margin (Johnson et al. 2001). When used alone, this drug may produce muscle tension, resulting in shaking, staring, increased body heat, and, on occasion, seizures. Usually, ketamine is combined with other drugs, such as xylazine. The combination of such drugs is used to control an animal, maximize the reduction of stress and pain, and increase human and animal safety.

Telazol is a more powerful anesthetic and usually used for larger animals. Telazol is a combination of equal parts of tiletamine hydrochloride and zolazepam hydrochloride (a tranquilizer). The product is generally supplied sterile in vials, each containing 500 mg of active drug, and when dissolved in sterile water has a pH of 2.2 to 2.8. Telazol produces a state of unconsciousness in which protective reflexes, such as coughing and swallowing, are maintained during anesthesia. Schobert (1987) listed the dosage rates for many wild and exotic animals. Before using Telazol, the size, age, temperament, and health of the animal are considered. 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 the 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.

Xylazine is a sedative (analgesic) that calms nervousness, irritability, and excitement, usually by depressing the central nervous system. Xylazine is commonly used with ketamine to produce a relaxed anesthesia. It can also be used alone to facilitate physical restraint. Because xylazine is not an anesthetic, sedated animals are usually responsive to stimuli. Therefore, personnel should be even more attentive to minimizing sight, sound, and touch. When using ketamine/xylazine combinations, xylazine will usually overcome the tension produced by ketamine, resulting in a relaxed, anesthetized animal (Johnson et al. 2001). This reduces heat production from muscle tension, but can lead to lower body temperatures when working in cold conditions.

Chemical Euthanasia Methods

Sodium Pentobarbital is a barbiturate that rapidly depresses the central nervous system to the point of respiratory arrest. Barbiturates are a recommended euthanasia drug for free-ranging wildlife (AVMA 2013). Sodium pentobarbital would only be administered after target animals have been live-captured and properly immobilized to allow for direct injection. There are United Stated Drug Enforcement Administration restrictions on who can possess and administer this drug. Some states may have additional requirements for personnel training and particular sodium pentobarbital products available for use in wildlife. Certified WS' personnel are authorized to use sodium pentobarbital and dilutions for euthanasia in accordance with United States Drug Enforcement Administration and state regulations. All animals euthanized using sodium pentobarbital and all of its dilutions (*e.g.* Beuthanasia-D, Fatal-Plus) would be disposed of immediately through incineration or deep burial to prevent secondary poisoning of scavenging animals and introduction of these chemicals to non-target animals.

Potassium Chloride used in conjunction with prior general anesthesia is used as a euthanasia agent for animals, and is considered acceptable and humane by the AVMA (2013). Animals that have been euthanized with this chemical experience cardiac arrest followed by death, and are not toxic to predators or scavengers.

Beuthanasia®-D combines pentobarbital with another substance to hasten cardiac arrest. Intravenous (IV) and intracardiac (IC) are the only acceptable routes of injection. As with pure sodium pentobarbital, IC injections with Beuthanasia®-D are only acceptable for animals that are unconscious or deeply anesthetized. With other injection routes, there are concerns that the cardiotoxic properties may cause cardiac arrest before the animal is fully unconscious. It is a Schedule III drug, which means it can be obtained directly from the manufacturer by anyone with a United States Drug Enforcement Administration registration. However, Schedule III drugs are subject to the same security and record-keeping requirements as Schedule II drugs.

Fatal-Plus® combines pentobarbital other substances to hasten cardiac arrest. IV is the preferred route of injection; however, IC is acceptable as part of the two-step procedure used by WS. 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. Like Beuthanasia®-D, it is a Schedule III drug requiring a United States Drug Enforcement Administration registration for purchase and is subject to the security and record-keeping requirements of Schedule II drugs.

Carbon dioxide is sometimes used to euthanize animals that are captured in live traps and when relocation is not a feasible option. Live animals are placed in a sealed chamber. Carbon dioxide gas is released into the chamber and the animal quickly dies after inhaling the gas. This method is approved as a euthanizing agent by the AVMA. Carbon dioxide gas is a byproduct of animal respiration, is common in the atmosphere, and is required by plants for photosynthesis. It is used to carbonate beverages for human consumption and is the gas released by dry ice. The use of carbon dioxide by WS for euthanasia purposes is exceedingly minor and inconsequential to the amounts used for other purposes by society.

Chemical Repellents

Repellents are usually naturally occurring substances or chemicals formulated to be distasteful or to elicit pain or discomfort for target animals when they are smelled, tasted, or contacted. Repellents are non-lethal chemical formulations used to discourage or disrupt particular animal behaviors. Olfactory repellents must be inhaled to be effective. These are normally gases, or volatile liquids and granules, and require application to areas or surfaces that need protecting. Taste repellents are compounds (*e.g*., liquids, dusts, granules) that are normally applied to trees, shrubs, and other materials that are likely to be eaten or gnawed by the target species. Tactile repellents are normally thick, liquid-based substances that are applied to areas or surfaces to discourage travel of wildlife by causing irritation such as to the feet.

Only a few repellents are commercially available for mammals, and are registered for only a few species. Repellents would not be available for many species that may present damage problems, such as some predators or furbearing species. For example, Miller et al. (2014) found a commonly available mammal repellent was not effective at repelling coyotes. Repellents are variably effective and depend largely on resource to be protected, time and length of application, and sensitivity of the species causing damage. Acceptable levels of damage control would usually not be realized unless repellents were used in conjunction with other techniques.

Fumigants

Large Gas cartridges (EPA Reg. No. 56228-21) are often used to treat dens or burrows of coyotes, red fox, or striped skunks. When ignited, the cartridge burns in the den of an animal and produces large amounts of carbon monoxide, a colorless, odorless, and tasteless, poisonous gas. The combination of oxygen depletion and carbon monoxide exposure kills the animals in the burrow or den. Sodium nitrate is the principle active chemical in gas cartridges and is a naturally occurring substance. Although stable under dry conditions, it is readily soluble in water and likely to be highly mobile in soils. In addition, dissolved nitrate is very mobile, moving quickly through the vadose zone to the underlying water table (Bouwer 1989). However, burning sodium nitrate, as in the use of a gas cartridge as a fumigant in a rodent burrow, is believed to produce mostly simple organic and inorganic gases, using all of the available sodium nitrate. In addition, the human health drinking water tolerance level for this chemical is 10 mg / L, a relatively large amount, according to EPA Quality Criteria for Water (EPA 1986, Wallace 1987). The gas, along with other components of the cartridge, are likely to form oxides of nitrogen, carbon, phosphorus, and sulfur. Those products are environmentally non-persistent because they are likely to be metabolized by soil microorganisms or they enter their respective elemental cycles. In rodent cartridges, sodium nitrate is combined with seven additional ingredients: sulfur, charcoal, red phosphorus, mineral oil, sawdust, and two inert ingredients. None of the additional ingredients in this formulation is likely to accumulate in soil, based on their degradation into simpler elements by burning the gas cartridge. Sodium nitrate is not expected to accumulate in soils between applications, nor does it accumulate in the tissues of target animals (EPA 1991). The EPA stated sodium nitrates "*...as currently registered for use as pesticides, do not present any unreasonable adverse effects to humans*" (EPA 1991). WS would only use gas cartridges in dens that show signs of active target animal use to minimize risks to non-target species.

Toxicants

Sodium Cyanide (EPA Reg. No. 56228-15) is used in the M-44 device, a spring-activated ejector device developed specifically to kill coyotes and other canids. The M-44 is a mechanical device that ejects sodium cyanide powder into the mouth of an animal that pulls up on it with its teeth. The M-44 is made of four parts and is set with special pliers. It is selective for canids (members of the dog family) due to their feeding behavior (scavenging) and because the attractants used are relatively canid-specific. When properly used, the M-44 device presents little risk to humans and the environment, and provides an additional tool to reduce predator damage. The M-44 device consists of: (1) a capsule holder wrapped with fur, cloth, or wool; (2) a capsule containing 0.97 grams of powdered sodium cyanide; (3) an ejector mechanism; and (4) a 5-7 inch hollow stake. The hollow stake is driven into the ground, the ejector unit is cocked and placed in the stake, and the capsule holder containing the cyanide capsule is screwed onto the ejector unit. A fetid meat or other suitable bait is spread on the capsule holder. A canine attracted by the bait will try to pick up or pull the baited capsule holder. When the M-44 device is pulled, a spring-activated plunger propels sodium cyanide into the animal's mouth. When it encounters carbon dioxide or acids, it forms hydrogen cyanide gas. Hydrogen cyanide gas is highly and quickly toxic by contact, ingestion, or inhalation of vapors at which time it enters the bloodstream. Hydrogen cyanide gas is an asphyxiant that prohibits the use of oxygen, which affects cellular activities and functions of all tissues in the body. The body is unable to use oxygenated blood (arterial blood). The body will respond to cyanide poisoning with a variety of symptoms depending on the amount of exposure. The characteristic response is a rapid loss of consciousness and cessation of breathing except with the mildest of exposures. After ingestion of a large dose of sodium cyanide, the target species may become unconscious within a few seconds. Breathing is rapid at first, but soon becomes slow and gasping. Convulsions may follow, but in severe poisoning cases, especially if untreated, coma and death may occur in a few minutes. WS' personnel would use required PPE to minimize exposure to sodium cyanide when placing and/or inspecting M-44 devices. WS' personnel must have a commercial pesticide applicators license issued by the ODAFF to use the M-44 device. WS' personnel would follow label requirements of the M-44 sodium cyanide capsules. The EPA label for the M-44 device includes 26 use restrictions, which must be followed.

APPENDIX C

WS' RESPONSE TO EVALUATION OF STUDIES BY TREVES ET AL. (2016)

Treves et al. (2016) evaluated 12 existing publications (5 non-lethal and 7 lethal methods) regarding the effectiveness of non-lethal and lethal methods for reducing predation on livestock. Their main conclusions included the following:

- Predator control methods to prevent livestock loss have rarely been subject to rigorous tests using the "*gold standard*" for scientific inference (random assignment to control and treatment groups with experimental designs that avoid biases in sampling, treatment, measurement, or reporting)
- Across the controlled experiments that they systematically examined, higher standards of evidence were generally applied in tests of non-lethal methods than in tests of lethal methods for predator control
- Non-lethal methods were more effective than lethal methods in preventing carnivore predation on livestock generally; at least two lethal methods (government culling or regulated, public hunting) were followed by increases in predation on livestock; zero tests of non-lethal methods had counterproductive effects
- All flawed tests came from North America; ten of 12 flawed tests were published in three journals, compared to four of 12 tests with strong inference in those same journals
- Treves et al. (2016) recommend suspending lethal predator control methods that do not currently have rigorous evidence for functional effectiveness in preventing livestock loss until gold standard tests are completed.

Specific Points Regarding the Article by Treves et al. (2016):

- Treves et al. (2016) recommend wildlife researchers apply the same standards used in controlled, laboratory settings to wildlife field research. Such standards (which involve randomized, controlled trials) are often not possible in field studies for a variety of reasons:
  - First, it can be difficult to find comparable units for evaluation. In the case of predation management, finding multiple field study sites that not only prohibit predator control, but also allow ranching, is difficult. Almost by definition, ranchers with high predation rates usually try to control predators, and ranchers with minimal problems do not.
  - Second, field studies involve a lot of variation. There are many factors from the weather to varying habitats to the movement of wildlife in and out of study areas that cannot be controlled and may affect results. This is the inherent nature of fieldwork.
  - Finally, to give sufficient statistical power, sample sizes must be large. Gathering sufficient data often involves multiple field seasons and field experts. Funding and other resources can limit the ability to conduct such studies.

- To conduct a completely randomized design, as suggested by Treves et al. (2016), would result in inherently large variability among sites and would necessitate such a large sample size that it would not be possible or practical in most instances. Two alternative field designs that are commonly used in wildlife research include a switch-back and paired block approach.
  - In the case of a predator control study, a switch-back design would involve at least two study areas, one (or more) with predator control and one (or more) without predator control. After at least 2 years of data collection, the sites would switch so that the one with predator control becomes the one without predator control and vice versa. An additional 2 years of data collection would occur. Research scientists with WS are currently involved in a controlled switch-back study like the one described above that is investigating the effectiveness of coyote control for reducing predation on deer populations in Utah.
  - The paired block design, involves finding multiple sites that are similar that can be paired and compared. For each pair, one site would experience predator control and one would not.

- The sloppy assessment of existing predation studies from North America and Europe by Treves et al. (2016) causes us to question their ability to accurately critique the scientific literature. Treves et al. (2016) did not accurately interpret or represent the designs and results of at least two of the studies reviewed in their paper.
    - In regards to Wagner and Conover (1999), Treves et al. (2016) makes a fundamental error in interpreting the study design. When researchers make changes to the independent variable, they measure the changes in the dependent variable. The purpose of the study was to determine the impact of preventive aerial operations (independent variable) as currently practiced by the WS program on sheep losses the following summer (dependent variable) AND the need for subsequent corrective predator damage management (*i.e*., the use of traps snares and M-44 devices - also a dependent variable) during the subsequent summer. Treves et al. (2016) mistakenly characterize use of traps, snares, and M-44 devices as independent variables which indicates a fundamental inattentiveness to the details of the study. This error led the authors to erroneously claim a variation that occurred in response to the treatment was either a willful misapplication of a control variable or a gross failure in study design. Wagner and Conover (1999) purposefully allowed corrective predator damage management to be conducted during the summer following aerial operations because, as practiced, it was highly improbable that preventive aerial operations would ever be used to the exclusion of all other methods for corrective predator damage management. Furthermore, if preventive aerial operations were effective, authors predicted one of two outcomes:
        1. losses on areas without aerial operations would be lower than losses in areas with aerial operations and there would be a corresponding decrease in use of traps, snares and M-44 devices; or,
        2. increased use of corrective predation management during the summer could be sufficient to keep losses at levels similar to areas with preventive aerial operations, but the amount of summer corrective predation damage management would be higher in areas without aerial operations. Traps, snares, and M-44 devices pose substantially different risks to non-target species than aerial operations. Wagner and Conover (1999) felt that this information was important when making management decisions regarding the use of preventive aerial operations.

      Treves et al. (2016) also states that the study is biased because "*control pastures started with 40% higher sheep densities*." However, the Treves et al. (2016) calculation of sheep densities was based on incomplete information and is not a valid interpretation of the density of sheep during the study period. In the study, sheep were not permitted to disperse evenly throughout the grazing allotments; instead, herders moved sheep bands through subsections of the allotments in accordance with established grazing management plans. Consequently, simply dividing the number of sheep on the allotment by the total size of the allotment, as was done, does not accurately reflect the density of sheep during the study.

      Treves et al. (2016) stated the study includes a reporting bias because "*data was not presented*" on livestock-guarding dogs. Wagner and Conover (1999) clearly stated that one of the criterion used for pairing allotments was the presence or absence of livestock guarding dogs. They did not pair allotments with livestock guarding dogs with allotments without livestock guarding dogs. Failure to provide data showing that that number of treated allotments with livestock guarding dogs matched the number of untreated allotments with livestock guarding dogs does not constitute a reporting bias.

  - Treves et al. (2016) incorrectly cites and confuses two different studies when citing Bromley and Gese (2009) in their paper. While citing Bromley and Gese (2009), Treves et al. (2016) is actually referring to a paper published in 2001 by Bromley and Gese (2001*a*). As a reason for study bias, Treves et al. (2016) mentions the study conducted by Bromley and Gese (2001*a*) (incorrectly cited as Bromley and Gese 2009 in their paper) includes a high overlap between coyote territories "…*because subsequent work showed that the home ranges and core areas of sterilized coyote packs overlapped territories of neighbors significantly more than those of intact coyote packs during the breeding season, when virtually all sheep predation occurred (Seidler and Gese 2012)*." However, the "*subsequent work*" that Treves et al. (2016) cites by Seidler and Gese (2012) was actually associated with a study involving coyote predation on pronghorn (*Antilocapra americana*) fawns that Seidler (2009) conducted many years later in a different state and in a completely different system (*i.e*., no sheep, different habitat types). Bromley and Gese (2001*b*) actually reports that coyote core areas overlapped only once (by 3%) and there was no statistically significant difference in overlap among coyote territories. In fact, to eliminate a potential inaccurate assignment of the coyotes responsible for making a kill, Bromley and Gese (2001*a*, 2001*b*) used the actual locations of the radioed coyotes as the method of assigning which coyote pack killed the sheep whenever there was overlap of territory boundaries between adjacent packs.

- Treves et al. (2016) included a paper by Musiani et al. (2003) that evaluated fladry as a non-lethal method to disperse wolves. However, a portion of the research conducted by Musiani et al. (2003) occurred on captive animals. The two field trials included in the paper by Musiani et al. (2003) did not meet the scientific standards outlined by Treves et al. (2016).

- Treves et al. (2016) selectively disregards studies from Australia. Those studies are some of the more rigorous field studies on working livestock operations with free-ranging, native carnivores that evaluate the effectiveness of lethal control. Given their explicit desire to make generalization about predation control, it is troublesome that Treves et al. (2016) would exclude this body of rigorous science.

WS understands and appreciates interest in ensuring predator damage management methods are as robust and effective as possible. WS supports the use of rigorous, scientifically sound studies, but we realize there are many variables that research scientist cannot control and assumptions that must be acknowledged when trying to answer complex ecological questions. WS does not believe there is a single standard for conducting wildlife field studies and each approach or design has its own unique assumptions, drawbacks, and challenges. WS does not believe that results from existing studies should be ignored. Wildlife research is inherently challenging because scientists are not working in a "*closed*" system. Science and the scientific method are a process. You build upon information gathered over years of study and experimentation. Results from one study lead to new questions and new studies.

WS' policies and decisions are based on the best available science. The NEPA requires federal agencies to evaluate environmental impacts into their decision-making processes and to ensure that environmental information is available to public officials and citizens before a federal agency makes decisions and before the agency takes actions. To fulfill this responsibility, WS prepares analyses of the environmental effects of program activities as part of the NEPA process. A description of and citations for various wildlife damage management actions occurs in the EA and in Appendix B.

WS encourages the use of non-lethal tools and techniques when feasible and practical; however, not all wildlife damage problems can be resolved using non-lethal techniques alone. Even with the use of single or combined non-lethal methods, livestock losses to predators often continue. When conducting lethal management activities, WS evaluates all potential tools for humaneness, effectiveness, ability to target specific individual animals and/or species, and the potential impact on human safety. Professional organizations such as The Wildlife Society, whose 10,000 members include scientists, managers, educators and others, have long supported the use of lethal removal. A Standing Position Statement issued by The Wildlife Society on wildlife damage management states, "*Prevention or control of wildlife damage, which often includes removal of the animals responsible for the damage, is an essential and responsible part of wildlife management*." The mission of WS is to manage wildlife damage. WS does not manage wildlife populations. The management of predators and other wildlife is the responsibility of the other state and other federal agencies. As such, any actions taken by WS to reduce wildlife damage occurs in collaboration with state and federal agencies and under appropriate state and federal permits and laws.

LITERATURE CITED

Bromley, C., and E. M. Gese. 2001*a*. Surgical sterilization as a method of reducing coyote predation on domestic sheep. Journal of Wildlife Management 65:510-519.

Bromley, C., and E. M. Gese. 2001*b*. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Canadian Journal of Zoology 79:386-392.

Musiani, M., C. Mamo, L. Boitani, C. Callaghan, C. C. Gates, L. Mattei, E. Visalberghi, S. Breck, and G. Volpi. 2003. Wolf depredation trends and the use of fladry barriers to protect livestock in western North America. Conservation Biology 17:1538-1547.

Seidler, R. 2009. Surgical sterilization of coyotes to reduce predation on pronghorn fawns. M.S. Thesis, Utah State University, Logan, Utah.

Seidler, R. G., and E. M. Gese. 2012. Territory fidelity, space use, and survival rates of wild coyotes following surgical sterilization. Journal of Ethology 1-10.

Treves, A., M. Krofel, and J. McManus. 2016. Predator control should not be a shot in the dark. Frontiers in Ecology and the Environment 14:380-388.

Wagner, K. K., and M. R. Conover. 1999. Effect of preventive winter aerial coyote hunting on sheep losses to coyote predation. Journal of Wildlife Management 63:606-612.