ENVIRONMENTAL ASSESSMENT
(FINAL)

EVALUATING THE USE OF AERIAL OPERATIONS IN SOUTH DAKOTA TO MANAGE DAMAGE TO LIVESTOCK ASSOCIATED WITH COYOTES AND RED FOX

Prepared by:

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

In consultation with:

South Dakota Game, Fish and Parks

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ACRONYMS

APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FR	Federal Register
FY	Fiscal Year
MOU	Memorandum of Understanding
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NWRC	National Wildlife Research Center
SDGFP	South Dakota Game, Fish and Parks
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. In general, people regard wildlife as providing economic, recreational, emotional, 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. Therefore, wildlife can have either positive or negative values depending on the perspectives and circumstances of individual people.

In South Dakota, the state agency responsible for managing wildlife is the South Dakota Game, Fish and Parks (SDGFP) (see South Dakota Codified Law, Title 41). The mission of the SDGFP is to provide "*…sustainable outdoor recreational opportunities through responsible management of our state's parks, fisheries and wildlife by fostering partnerships, cultivating stewardship and safely connecting people with the outdoors*" (SDGFP 2017*a*). The SDGFP recognizes the importance of working cooperatively "*…with private landowners and livestock producers in the State to resolve many types of wildlife damage…*" because "[p]*rivate lands in South Dakota produce the majority of wildlife that reside in the state…*" (Fisk 2017). To maintain those important relationships with private landowners, the SDGFP implements a statewide program to manage damage and threats of damage associated with wildlife (see Section 1.4.1). Working with livestock producers to reduce predation on livestock by predators is a major component of the program administered by the SDGFP to manage wildlife damage (Fisk 2017, Fisk 2018). In support of their program to manage wildlife damage, the SDGFP has requested the assistance of the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS)[1] program with conducting aerial operations to manage livestock predation associated with coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*) in the State. More specifically, the SDGFP has requested that WS only provide assistance with aerial operations when an employee of the SDGFP and/or a tribal entity has determined aerial operations are an appropriate method to alleviate livestock predation associated with coyotes and red fox.

1.2 PURPOSE OF THIS DOCUMENT

The WS program is the lead federal agency responsible for managing conflicts with wildlife (USDA 2013)(see WS Directive 1.201)[2]. The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental planning into federal agency actions and decision-making processes (Public Law 9-190, 42 USC 4321 et seq.). Therefore, providing aerial operations to assist the SDGFP with managing predation on livestock associated with coyotes and red fox would be a federal action requiring compliance with the NEPA. The NEPA requires federal agencies to have available and fully consider detailed information regarding environmental effects of federal actions and to make information regarding environmental effects available to interested persons and agencies.

1.2.1 Complying with the NEPA

As part of the decision-making process associated with the NEPA, WS follows the Council on Environmental Quality (CEQ) regulations implementing the NEPA (40 CFR 1500 et seq.) along with the implementing procedures of the USDA (7 CFR 1b) and the APHIS (7 CFR 372). The NEPA sets forth

[1]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).

[2]At the time of preparation, WS' Directives occurred at the following web address: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_WS_Program_Directives.

the requirement that federal agencies evaluate their actions in terms of their potential to significantly affect the quality of the human environment to avoid or, where possible, to mitigate and minimize adverse impacts, making informed decisions, and including agencies and the public in their planning to support informed decision-making.

To comply with the NEPA and CEQ regulations, WS is preparing this Environmental Assessment (EA) to evaluate alternative means of achieving the objectives of WS and to determine whether the potential environmental effects caused by the alternatives might be significant, requiring the preparation of an Environmental Impact Statement (EIS). As described by the CEQ (2007), the intent of an EA is to provide brief but sufficient evidence and analysis to determine whether to prepare an EIS, aid in complying with the NEPA when an EIS is not necessary, and to facilitate preparation of an EIS when one is necessary. The CEQ (2007) further states, "*The EA process concludes with either a Finding of No Significant Impact…or a determination to proceed to preparation of an EIS*".

1.2.2 Using this EA to Inform WS' Decisions

Although WS only provides assistance when requested, WS is required to comply with the NEPA before making final decisions about actions that could have environmental effects. WS will use the analyses in this EA to help inform agency decision-makers, including a decision on whether the alternative means of meeting the need for action requires the preparation of an EIS or the EA process concludes with a Finding of No Significant Impact.

Another major purpose of the NEPA is to include other agencies and the public during the planning process to support informed decision-making. Prior to making and publishing the decision[3] to conclude this EA process, WS will make this EA available to the public, agencies, tribes, and other interested or affected entities for review and comment. Making the EA available to the public, agencies, tribes, and other interested or affected entities during the planning process will assist with understanding applicable issues and reasonable alternative means to meeting the request for assistance (see Section 1.1, Section 1.4) and to ensure that the analyses are complete for informed decision-making.

Public outreach notification methods for this EA will include posting a notice on the national WS program webpage and on the www.regulations.gov webpage. In addition, WS will send out direct mailings to local known stakeholders and will send out an electronic notification to stakeholders registered through the APHIS Stakeholder Registry. At a minimum, WS will also publish a notice in the legal section of the *Capital Journal* newspaper. WS will provide for a minimum of a 30-day comment period for the public and interested parties to review the EA and provide their comments. See Section 4.1 of this EA for additional information on the public participation process followed by WS. WS will inform the public of the decision using the same venues, including direct mailed notices to all individuals who submit comments by mail and provide mailing addresses.

WS will coordinate the preparation of this EA with interested partner agencies and tribes to facilitate planning, to facilitate efficient use of agency and tribal expertise, and to promote interagency and tribal coordination. WS also recognizes the sovereign rights of Native American tribes to manage wildlife on tribal properties. WS has invited all federally recognized tribes in South Dakota to cooperate or participate in the development of this EA. WS is committed to coordinating with all applicable land and resource management agencies, including tribes, when implementing the alternative means of meeting the need for action. WS has asked each interested agency to review the draft EA and provide input and direction to WS to ensure proposed activities would comply with applicable federal and state regulations

[3]As discussed in Section 1.2.1, the EA process concludes with either a Finding of No Significant Impact or the publication of a Notice of Intent to prepare an EIS.

and policies, federal land management plans and joint Memorandum of Understanding (MOU), and cooperative agreements.

1.2.3 The Geographical Scope of this EA and Areas Where WS' activities could occur

WS has decided that one EA analyzing potential effects of implementing the alternatives means of meeting the need for action for the entire State of South Dakota provides a more comprehensive and less redundant analysis than multiple EAs covering smaller regions. This approach also provides a broader scope for the effective analysis of potential cumulative impacts and for using data and reports from state and federal wildlife management agencies, which are typically on a statewide basis.

Coyotes and red fox occur statewide and throughout the year in South Dakota. Therefore, predation and predation risks to livestock can occur statewide and throughout the year, wherever coyotes, red fox, and livestock overlap. Responding to requests for assistance falls within the category of actions in which the exact timing or location of individual requests for assistance can be difficult to predict with sufficient notice to describe accurately the locations or times in which WS could reasonably expect to be acting. Although WS could predict some of the possible locations or types of situations and sites where some requests for assistance could occur, the program cannot predict the specific locations or times at which affected resource owners would determine that livestock predation had become unacceptable to the point that they seek assistance. In addition, WS would only provide assistance when personnel with the SDGFP and/or a tribal entity determine that aerial operations are an appropriate method to alleviate livestock predation (see Section 1.1) and only after the appropriate landowner or manager agrees to allow aerial operations on the property they own or manage. Therefore, WS must be ready to provide assistance on short notice anywhere in South Dakota when receiving a request for assistance.

The analyses in this EA would apply to any aerial operations that WS may conduct in any locale and at any time within South Dakota when WS receives a request for such assistance from the SDGFP and/or a tribal entity. As discussed previously, an employee of the SDGFP and/or a tribal entity would determine when aerial assistance from WS was appropriate. Therefore, WS would only conduct aerial operations after receiving a request from the SDGFP and/or a tribal entity and only after the appropriate landowner or manager signed a work initiation document or a similar document allowing WS to conduct aerial operations on the property they own or manage. Therefore, this EA meets the intent of the NEPA with regard to site-specific analysis, informed decision-making, and providing the necessary timely assistance to those people seeking assistance.

The geographic scope of the actions and analyses in this EA is statewide. The SDGFP administers a statewide program to manage damage caused by wildlife in South Dakota, including predation occurring to livestock. Therefore, if WS assists the SDGFP, WS could conduct aerial operations on private, federal, state, county, and municipal property when personnel from the SDGFP determine aerial operations are appropriate to alleviate livestock predation or livestock predation risks. In addition, WS would only conduct aerial operations after the appropriate landowner or manager signs a work initiation document allowing WS to conduct aerial operations on the property they own or manage. When conducting activities on state or federal properties, WS would conduct activities based on interagency agreements, which may require close coordination and cooperation because of related or overlapping authorities and legal mandates. WS would coordinate closely with other federal and state agencies, including the Bureau of Land Management, the United States Forest Service, the United States Fish and Wildlife Service (USFWS), the National Park Service, and the SDGFP (see Section 1.4.8). Therefore, the scope of this EA analyzes actions that could occur on federal, state, county, city, and private lands, when requested.

Tribal governments and land managers could also request assistance from the SDGFP and/or WS to manage livestock predation on lands under tribal authority and/or ownership. Therefore, if WS assists the

SDGFP, WS could conduct aerial operations on tribal properties after the appropriate tribal landowner or tribal authority signs a MOU, work initiation document, cooperative service field agreement, or a similar document allowing WS to conduct aerial operations on property under tribal authority and/or ownership. Therefore, tribal authorities and/or tribal landowners would determine when assistance was appropriate on lands under tribal authority and/or ownership and what methods were appropriate.

In addition, wildlife plays an important role in tribal culture and religious beliefs. WS would work with tribal governments to address their needs through consultation for this EA, with policy, and when providing assistance, as requested. Work conducted at the request of tribal governments would be consistent with tribal decisions, values, and traditions as determined by the Tribal government through government-to-government consultations.

1.2.4 Period for which this EA is Valid

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

If WS assists the SDGFP, WS would periodically monitor activities conducted by its personnel to ensure those activities and their impacts remain consistent with the activities and impacts analyzed in this EA and selected as part of the decision. Monitoring activities would ensure that program effects occurred within the limits of evaluated/anticipated activities. Monitoring involves review of the EA for all of the issues evaluated in Chapter 3 to ensure that the activities and associated impacts have not changed substantially over time.

1.3 PREPARATION OF AN EA INSTEAD OF AN EIS

One comment that WS often receives during the public involvement process associated with the development of an EA is that WS should have prepared an EIS instead of an EA or that proposed activities require the development of an EIS. As discussed in Section 1.2, the primary purpose for developing an EA is 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 (see 40 CFR 1508.9(a)(3), 40 CFR 1501.4). WS prepared this EA so that WS can make an informed decision on whether or not an EIS would be necessary if WS implemented the alternative approaches to meeting the need for action.

WS 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, available literature (see Appendix A), interagency consultations, and public involvement.

If WS makes a determination, based on this EA, that the selected alternative would have a significant impact on the quality of the human environment, WS would publish a Notice of Intent to prepare an EIS. This EA would be the foundation for developing that EIS in accordance with the NEPA implementing regulations of the CEQ (40 CFR 1508.9(a)(3)).

1.3.1 How WS will Evaluate Significant Impacts

The process for determining if a project or program may have significant impacts is based on the CEQ regulations at 40 CFR 1508.27. Chapter 3 evaluates the direct, indirect, and cumulative impacts associated with the alternative means of meeting the need for action. The need for action involves the request for assistance received by WS from the SDGFP to conduct aerial operations that supports the efforts of the SDGFP with managing predation risks to livestock associated with coyotes and red fox in South Dakota, which could include conducting activities at the request of a tribal entity (see Section 1.4).

Most of the factors included in 40 CFR 1508.27(b) include the phrase "*the degree to which*" a particular type of resource might be adversely affected, not a determination of no adverse impact at all. Therefore, WS evaluates the impacts to resources and documents the predicted effects in this EA. WS will use those effect analyses to determine if the levels of impact are indeed "*significant*" impacts for which a Finding on No Significant Impact would not be appropriate; thus, requiring the need to prepare an EIS. If WS determines that the levels of impacts are not significant, WS will document the rationale for not preparing an EIS in a publicly available Decision and Finding of No Significant Impact in accordance with guidance from the CEQ. WS will review the impacts evaluated in Chapter 3 of this EA in two ways: the severity or magnitude of the impact on a resource and the context of the impact. For example, WS may consider the context of activities when the resource is rare, vulnerable, not resilient, or readily changed long-term with even a short-term stressor.

The factors identified in 40 CFR 1508.27 are not checklists, nor do they identify thresholds of impacts, but they are factors for consideration by the agency while making the decision regarding whether to prepare a Finding of No Significant Impact or preparing an EIS. WS will determine how to consider those factors in its decision on whether to prepare a Finding of No Significant Impact or an EIS. WS will determine the *degree* to which a factor applies or does not apply to the impacts documented in the EA. An outline of how WS will use this EA and the criteria at 40 CFR 1508.27 to make the decision regarding whether a Finding of No Significant Impact or an EIS is appropriate occurs below (see Section 1.3.2 through Section 1.3.7).

1.3.2 Controversy Regarding Effects

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

For example, a relatively recent comment raised in response to other EAs developed by WS suggests that scientific controversy exists regarding WS' activities to manage damage associated with predators considered to be at the top of the ecological food chain ("*apex predators*") that can cause "*trophic cascades*" resulting in reductions in biodiversity. This comment argues that changes at the top of the food chain (such as coyotes) may result in ecological changes, including releases of populations of smaller predators (such as fox or raccoons), in which other, often smaller predator populations may be released from suppression caused by larger predators. Section 3.2.1 evaluates this ecological issue and its cumulative impact analysis in detail.

1.3.3 Unique or Unknown Risks

Another concern commonly expressed in comments involves the potential for unknown or unavailable information (40 CFR 1502.22) to potentially result in uncertain, unique, or unknown risks (40 CFR 1508.17(b)(5)), especially related to population numbers and trends and the extent and causes of mortality of wildlife species. Throughout the analyses in this EA, WS uses the best available data and information, such as information from the SDGFP, which has jurisdiction by law to manage the coyote and red fox population in South Dakota (40 CFR 1508.15). In addition, WS will use the scientific literature, especially peer-reviewed scientific literature, to inform its decision-making.

Population and mortality data for many native wildlife species, including coyotes and red fox, are typically non-existent from any source, in or outside of South Dakota. WS recognizes that estimating wildlife populations over large areas can be extremely difficult, labor intensive, and expensive. Instead, the SDGFP may choose to monitor population health using other factors, such as sex ratios, age distribution of the population, indices of abundance, and/or trend data to evaluate the status of populations that do not have direct population data. This EA uses the best available information from wildlife management agencies, including the SDGFP when available, and available literature to assess potential impacts to wildlife species.

If population estimates are available, then the analyses will use the lowest density or number estimates for wildlife species populations (where high and low population estimates are provided in the text) to arrive at the most conservative impact analysis. Coordination with the SDGFP and providing the opportunity for agency review of and involvement in this EA ensure that analyses are as robust as is possible. The analyses in this EA provide information for WS to determine if WS' contribution to cumulative mortality from all sources would adversely affect the coyote and/or the red fox population in South Dakota, and non-target wildlife species.

Section 3.2 of this EA analyzes the environmental consequences of the alternatives 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 WS would publish a notice of intent to prepare an EIS and this EA would be the foundation for developing the EIS.

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

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

Evaluation of those issues occurs in the following sections of this EA:

- Impacts to threatened and endangered species occurs in Section 3.2.2
- Impacts to unique geographic areas occurs in Section 2.1.2
- Impacts to cultural and historic resources occurs in Section 2.1.2

- Compliance with other environmental laws occurs in Section 1.4.7 (compliance with statutes and executive orders) and Section 2.3 (Standard Operating Procedures)

1.3.5 Cumulatively Significant Impacts

Another common comment involves the criterion for the analysis of "*cumulatively significant impacts*" (40 CFR 1508.27(b)(7)), which this EA considers in various ways. 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. Cumulative impacts could potentially 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. Many of the issues evaluated in detail within Section 2.1.1 are inherently cumulative impact analyses. For example:

- Impacts to coyote and red fox populations, as each population has many sources of mortality, only one of which could be removal by WS
- Impacts to wildlife species listed as threatened or endangered pursuant to the Endangered Species Act (ESA), as these species' populations are already cumulatively impacted by many sources of mortality, loss of habitat, climate change, and other stressors, causing them to be listed
- Potential ecological impacts caused by removal of apex predators, as many ecological factors contribute to any resulting impacts
- Potential for lead from ammunition to impact environmental and human factors, as there are many sources of lead in the environment, including lead from hunting activities, and lead may chronically enter the environment and people over time.

1.3.6 Public and Employee Health and Safety

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

- The potential for people to ingest lead sourced from ammunition through water occurs in Section 2.1.2
- The potential for hazardous chemicals being spilled or leached into surface and groundwater, and being ingested by people occurs in Section 2.1.2 (lead ammunition) and Section 3.2.3 (threats to human health and safety)
- The risk of injury to WS' employees during aerial operations occurs in Section 3.2.3

1.3.7 Impacts Can Be both Beneficial and Adverse

Some commenters may believe that WS must prepare an EIS because the protection of livestock is extremely beneficial based on 40 CFR 1508.27(b)(1). It is important that WS identify the beneficial outcomes and effects, as well as adverse effects, as contributions to informed decision-making. This EA evaluates the impacts associated with implementing the proposed activities in Chapter 3.

1.4 THE 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, 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 wildlife 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 wildlife, in many cases, the wildlife acceptance capacity is lower or already met. Once the wildlife 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 wildlife acceptance capacity helps define the range of wildlife population levels and associated damages acceptable to individuals or groups (Decker and Brown 2001).

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 wildlife 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.

1.4.1 The Role of the SDGFP in Managing Damage Caused by Wildlife in South Dakota

In South Dakota, the SDGFP is responsible for managing wildlife populations within the State, including the populations of coyotes and red fox. As part of its responsibility with managing wildlife populations within the State, the SDGFP "…*operates a multifaceted, comprehensive wildlife damage management program, which is designed to address human-wildlife conflicts*" (Longmire 2015). Employees of the SDGFP work cooperatively with landowners and producers to alleviate or reduce all types of wildlife damage, including alleviating livestock losses associated with coyotes and fox (Fisk 2017, Fisk 2018). The SDGFP conducts a program that integrates the use of many methods to alleviate wildlife damage. The State of South Dakota fully funds the program to manage wildlife damage through livestock assessments and surcharges on hunting licenses (Fisk 2017, Fisk 2018).

In 1939, the South Dakota state legislature passed a law that established an Animal Damage Control program within the SDGFP. The Animal Damage Control program within the SDGFP was established to provide assistance with managing livestock losses from predators, including coyotes and red fox, and damage caused by beaver (*Castor canadensis*), mink (*Neovison vison*), badgers (*Taxidea taxus*), raccoons (*Procyon lotor*), and other animals (see South Dakota Codified Law 40-36-9) (Longmire 2015, Fisk 2017). In 1999, as the populations of other wildlife species, such as deer (*Odocoileus* spp.), elk (*Cervus* *canadensis*), wild turkeys (*Meleagris gallopavo*), and Canada geese (*Branta canadensis*), increased, the state legislature passed legislation that established a funding mechanism to expand the assistance provided by the SDGFP to include additional wildlife species. Based on the funding mechanism established in 1999, the SDGFP implemented a Wildlife Damage Management program, which provides assistance with managing damage to stored-feed supplies caused by deer, elk, and wild turkeys, along with managing damage to crops associated with Canada geese, elk, deer, and pronghorn (*Antilocapra americana*) (Longmire 2015, Fisk 2017, Fisk 2018). In 2009, the SDGFP formally consolidated the Animal Damage Control component and the Wildlife Damage Management component into the comprehensive Wildlife Damage Management program that the SDGFP administers today (Fisk 2017).

The SDGFP can enter into cooperative agreements with federal agencies to control coyotes, fox, and other wild animals that are injurious to livestock, poultry, and other property, including posing threats to human safety (see South Dakota Codified Law 40-36-1). The SDGFP has requested that WS incorporate its aircraft and pilots into the damage management program administered by the SDGFP to reduce economic losses associated with coyotes and red fox killing livestock in the State. The request would include conducting activities on properties owned and/or managed by a tribe in South Dakota when a tribal entity requests such assistance from the SDGFP and/or WS. Under South Dakota Codified Law 41-9-39.2, the SDGFP can contract with entities to conduct aerial operations to control fox and coyotes pursuant to the Airborne Hunting Act (Public Law 92-159) and South Dakota Codified Law 40-36-9.

1.4.2 Contribution of Livestock to the Economy in South Dakota

Agricultural production is the leading industry in South Dakota generating 20% of the economic activity within the State. The production of agriculture has a $25.6 billion economic impact each year within the State with more than 19 million acres of cropland and 23 million acres of pastureland contributing to agricultural production within the State. Nearly one in every five jobs in South Dakota involves production agriculture and agriculture-related industries (South Dakota Department of Agriculture 2012).

The production of livestock accounts for $8.6 billion of the economic production in the State and is responsible for 30,303 jobs (Decision Innovation Solutions 2014). In 2015, the National Agricultural Statistics Service (NASS) ranked South Dakota fifth in the United States in the production of beef cows, calves, and lambs, sixth in the production of sheep and lambs, seventh in production of cattle and calves, and eleventh in the production of swine (NASS 2016).

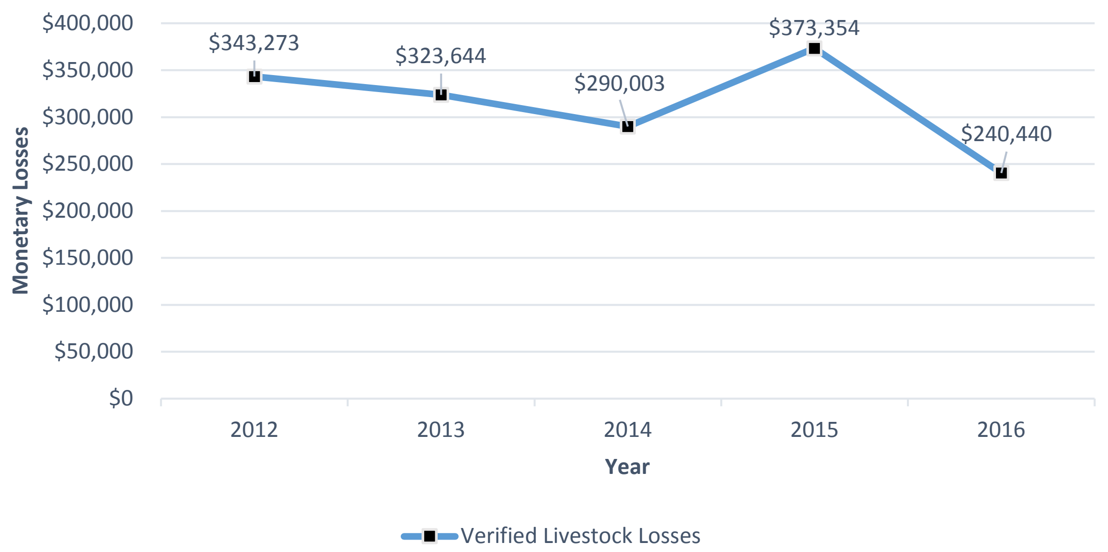
The results of a recent analysis conducted by Decision Innovation Solutions (2014) indicate "*…that agriculture is a critical component of South Dakota's overall economic well-being. South Dakota agriculture is connected to a large integrated set of industries – from the production of agricultural commodities to food and feed processing to agricultural input manufacturing and many other ag-support industries. The results of the analysis indicate that diminishment or removal of any one of them will likely cause significant negative impacts to the others*."

1.4.3 Livestock Predation by Coyotes and Red Fox in South Dakota

Predation on livestock is well documented, with coyotes likely responsible for the highest percentage. Coyotes are the primary predator to cattle (Knowlton et al. 1999, 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, Shelton 2004, NASS 2005, NASS 2010, Sacks and Neale 2007, Palmer et al. 2010, APHIS Veterinary Services 2015). For example, 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 coyotes killed but had not fed upon 25% of those sheep killed by coyotes (Nass 1977). DeLorenzo and Howard (1977) found that coyotes were the predominant predator on sheep during a study in Colorado. Further, DeLorenzo and Howard (1977) found that coyotes had not fed on more than 43% of the lambs killed by coyotes. Similarly, coyotes were the primary predator on sheep during a Wyoming study and essentially the only predator in winter (Tigner and Larson 1977).

From 2012 through 2016, personnel with the SDGFP verified nearly $1.6 million in cattle and sheep losses to predators in South Dakota (see Figure 1) (K. Fisk, SDGFP pers. comm. 2017). In 2016, personnel with the SDGFP verified $240,440 in losses to cattle and sheep in South Dakota associated with predators, primarily coyotes and red fox.

Figure 1 - SDGFP verified cattle and sheep losses to predators in South Dakota



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 South Dakota. 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*" because the livestock producer did not purchase those animals. Those factors limit the ability of livestock producers to recover financial losses.

1.4.4 Livestock Losses from Predation compared to Livestock Losses from Other Sources

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 9.5% in South Dakota. In comparison, the percentage of the lamb crop lost in the State from predators was 3.1% during 2014 (APHIS Veterinary Services 2015). In 2015, nearly 98% of all adult cattle deaths and nearly 89% of all calf deaths occurred from causes other than predators (APHIS Veterinary Services 2017). 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.

Coyotes and/or red fox can prey upon a wide variety of livestock, including cattle, sheep, goats, swine, exotic pen-raised game, other hoofed-stock, and poultry. According to the APHIS Veterinary Services (2017), the percentage of calf deaths that producers attribute to predators has increased from 3.5% in 1995 to 11.1% in 2015. 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). In addition, 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 can result 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). 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).

The SDGFP has conducted activities to manage damage caused by predators in the State for many years. Therefore, livestock losses in South Dakota reported by the NASS and other entities are the losses that occur with the SDGFP 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 the SDGFP 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 occur in localized areas and can be economically burdensome for an individual producer.

1.4.5 The Need for Action Identified by the WS program

Because the State of South Dakota implements and funds a program to manage wildlife damage through the SDGFP, the WS program only provides limited assistance within the State, and generally, only at the request of the SDGFP. Therefore, the State of South Dakota has identified a need to provide assistance with managing damage associated with wildlife in the State. In support of their program to manage wildlife damage, the SDGFP has requested the assistance of WS with conducting aerial operations to manage livestock predation associated with coyotes and red fox; therefore, the SDGFP has determined a need to conduct aerial operations exists within the State. If the SDGFP and/or WS receive a request for assistance from a tribal entity to conduct aerial operations to alleviate livestock predation associated with coyotes and/or red fox, the tribal entity would determine when a need exists.

The national WS program has the infrastructure and guidelines in place to conduct aerial operations in support of activities to alleviate wildlife damage. The national WS program uses aircraft for specific projects to manage wildlife damage, such as shooting, tranquilizing, hazing, or surveying wildlife that are causing damage or posing a threat of damage. To ensure safety, the national WS program established an Aviation Training and Operations Center to help train agency and contract pilots, as well as crewmembers, in a variety of measures to reduce accidents and improve safety associated with flying. WS Directive 2.620 provides authority and assigns responsibility for the adherence to standards for the safe use of aircraft during activities conducted by the national WS program. WS Directive 2.620 also states, "*The mission of the WS Aviation Training and Operations Center…is to improve aerial operations safety and provide training and guidance for WS aviation personnel and aerial activities*." WS has also developed a comprehensive Aviation Operations and Safety Manual that provides guidance for WS' personnel when conducting aerial operations. Therefore, the need for action identified by WS is whether to assist the SDGFP by conducting aerial operations using aircraft owned or leased by WS and the associated personnel (*i.e*., pilot and crewmembers), which could include conducting activities on properties owned and/or managed by the tribes in South Dakota when the appropriate tribal entity requests such assistance.

1.4.6 The Federal Law Authorizing WS' Actions

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).

1.4.7 Statutes and Executive Orders that would apply to WS' Activities

In addition to the NEPA and those South Dakota Codified Laws discussed in Section 1.4.1, several statutes and executive orders would be relevant to activities that WS could conduct when providing assistance to the SDGFP. This section discusses several laws and executive orders that would be highly relevant to the WS program when providing assistance.

Endangered Species Act

Under the 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 (Section 2(c)). Evaluation of the alternatives in regards to the ESA will occur in Section 3.2.2 of this EA.

National Historic Preservation Act

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.

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.

Wilderness Act

The Wilderness Act (16 USC 1131-1136) established a national preservation system to protect areas "*where the earth and its community life are untrammeled by man*" in the United States. Wilderness Areas are devoted to the public for recreational, scenic, scientific, educational, conservation and historical use. Section 4(d)(4)(2) of the Wilderness Act states, "*Within wilderness areas in the national forests designated by this Act, … (2) the grazing of livestock, where established prior to September 3, 1964, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture*." The Wilderness Act preserved management authority for fish and wildlife with the state for those species under state jurisdiction (Section 4(d)(8)). Some portions of Wilderness Areas in South Dakota have historic grazing allotments and permittees could request assistance with livestock predation from the SDGFP.

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 (see Section 3.2.3).

Protection of Children from Environmental Health and Safety Risks - Executive Order 13045

For many reasons, children may suffer disproportionately 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. This EA will evaluate activities addressed in the alternatives for their potential impacts on human health and safety, including children, in Section 3.2.3.

1.4.8 Coordinating Activities with other Federal Agencies

The United States Forest Service within the USDA and the USFWS, the National Park Service, and the Bureau of Land Management within the United States Department of Interior are federal agencies with land management responsibilities within the United States, including the State of South Dakota. Those agencies have the responsibility to manage the resources on federal lands under their jurisdictions for multiple uses, which may include livestock grazing, timber production, recreation, and wildlife habitat. WS currently has signed national-level MOUs with the United States Forest Service, the USFWS, and the Bureau of Land Management, which recognize WS' responsibilities for wildlife damage management and outline the roles and responsibilities of each agency. If WS continues to conduct aerial operations, WS would coordinate with the appropriate federal land managers before conducting activities on lands under their jurisdiction. WS would continue to coordinate activities with appropriate federal land managers to ensure activities conducted by WS on properties under their jurisdiction were consistent with MOUs, work plans, and management plans. Coordination would occur within timeframes consistent with MOUs signed by WS and the federal land management agency. In most cases, coordination meetings would occur at least annually.

1.4.9 Effectiveness of Methods to address Livestock Predation

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. As discussed in Section 1.4.5, the SDGFP has requested that WS provide assistance by integrating WS' aerial operations into the program administered by the SDGFP to manage wildlife damage in the State. More specifically, WS would use aircraft to locate, pursue, and shoot coyotes and/or red fox to alleviate livestock predation when personnel with the SDGFP and/or tribal entities determine the use of an aircraft is appropriate and when the property owner or manager allows aerial operations to occur on property they own or manage.

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. When WS receives a request for assistance, the objective would be to conduct aerial operations in the most effective manner while minimizing the potentially harmful effects on people, target and non-target species, and the environment. 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. Although cost effectiveness may also be a consideration, the cost of management may sometimes be secondary because of overriding environmental, legal, human health and safety, animal welfare, or other concerns. In addition, the CEQ does not require a formal, monetized cost benefit analysis to comply with the NEPA.

The goal would be to alleviate livestock predation associated with coyotes and/or red fox as requested and not to reduce/eliminate the coyote and/or red fox population. 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.

The WS program often receives comments that lethal methods would be ineffective because other coyotes and/or red fox from surrounding areas would likely move into the area in which the lethal removals occurred. In addition, some commenters claim that because coyotes and/or red fox move in to an area after initial removal efforts were complete, the use of lethal methods would create a financial incentive to continue the use of only lethal methods. Those statements assume coyotes and/or red fox only return to an area where damage was occurring if the WS program or other entities used lethal methods. However, the use of non-lethal methods would also often be temporary, which could result in coyotes and/or red fox 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 coyotes and/or red fox would return if suitable conditions continued to exist at the location where damage was occurring and coyote and/or red fox densities were sufficient to occupy all available habitats to the extent that livestock predation occurs. Therefore, any reduction or prevention of livestock predation would be temporary if conditions continue to exist that attract coyotes and/or red fox to an area where damage was occurring.

Research has shown that in areas without some level of damage management, predation 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). Shwiff and Merrell (2004) reported a 5.4% increase 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 where removal of coyotes occurred 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 operations occurred, but increased 35% on allotments where no aerial operations occurred (Wagner and Conover 1999).

Using public satisfaction can also be a measure of the effectiveness of damage management activities. In a survey conducted by Longmire (2015), coyotes were the number one species that livestock producers requested help with from the SDGFP, while fox ranked third. Longmire (2015) found that 80% of livestock producers were "*satisfied*" or "*very satisfied*" with the assistance they received from the SDGFP.

1.5 ACTIONS THAT ARE OUTSIDE THE AUTHORITY OF WS

The WS program does not have any authority to manage wildlife other than the authority provided by Congress for assisting with damage or threats of damage associated with wildlife. Each state, including South Dakota, has full authority and jurisdiction to manage the native wildlife within its boundaries, unless a law grants an authority to another governmental authority. For example, the USFWS is the federal agency responsible for wildlife species listed as threatened or endangered pursuant to the ESA. The State of South Dakota also maintains a state list of species listed as threatened or endangered (see South Dakota Codified Law 34A-8), which is promulgated by the South Dakota Game, Fish and Parks Commission (see South Dakota Codified Law 34A-8-3).

In South Dakota, the SDGFP is responsible for managing wildlife populations, including the establishment of hunting and/or trapping seasons. As part of its authority to manage statewide wildlife populations, the SDGFP implements and receives state funding to assist people with managing wildlife damage in the State. The actions, decisions, and program implementation of the SDGFP are outside the authority of WS, including the actions, decisions, and implementation of the SDGFP program to manage wildlife and wildlife damage in the State. WS only provides assistance with managing wildlife damage after receiving a request for such assistance and only implements those methods the cooperator agrees to allow WS to use. As discussed in Section 1.4, the SDGFP has determined the only assistance they require from WS is the use of aircraft and the associated pilots and crewmembers to manage predation to livestock by coyotes and red fox in the State. Personnel with the SDGFP and/or a tribal entity would determine when the use of an aircraft was appropriate to alleviate livestock predation associated with coyotes and/or red fox and would contact WS. Before WS could conduct activities, the appropriate landowner or manager would have to agree to allow WS to conduct aerial operations by signing a MOU, work initiation document, cooperative service field agreement, or another similar document. Therefore, the only method that WS is considering in this EA is the use of aircraft and associated pilots and crewmembers to perform aerial operations as requested by the SDGFP and/or a tribal entity.

The use of other methods or approaches by WS, such as compensating people for livestock losses, the establishment of a bounty system for coyotes and/or red fox, referring people to private wildlife control agents or trappers, or the use of reproduction inhibitors are all actions that are outside the scope of this EA. In addition, the cultural practices or the methods that livestock producers use or do not use to prevent or alleviate livestock predation are outside the scope of this EA.

Some members of the public have expressed concern that WS' assistance amounts to a government subsidy of business costs for agricultural producers and more sound agricultural practices should replace agriculture producers that cannot survive without government assistance. 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). Therefore, changing the agricultural practices that people conduct is not within the authority of the WS program. For example, the number of cattle that people raise and where people raise cattle is outside the authority of the WS program.

WS only has the authority to determine national policy for its own federal resources. WS has no authority to determine national policy regarding use and commitment of local, state, tribal, or other federal resources, or lands for economic use by private entities, such as livestock grazing or timber growth and harvest, or use of private land, such as for livestock feedlots, or government, commercial, or residential development.

WS does not have the authority to make decisions regarding the management or use of public lands. Policies that determine the multiple uses of public lands occur pursuant to federal laws, such as the Taylor Grazing Act of 1934 and the Federal Land Policy and Management Act for the Bureau of Land Management, and the Forest Service Organic Act of 1897 and the Multiple Use-Sustained Yield Act of 1960 for the United States Forest Service. Congressional appropriations support the implementation of those authorities. Therefore, the activities that other agencies allow to occur on public lands are outside of the authority of the WS program. Livestock grazing in South Dakota occurs at the discretion of the property owner or manager without involvement from the WS program or any activities conducted by the WS program. Therefore, WS' assistance would not automatically trigger livestock grazing. Livestock grazing clearly can and would proceed in the absence of assistance provided by the WS program.

CHAPTER 2: ISSUES AND ALTERNATIVES

The WS program in South Dakota[4] has identified a need for action based on a request for assistance from the SDGFP (see Section 1.4). WS has identified several issues associated with the activities that WS could implement to meet that need for action. Issues are concerns regarding potential effects that might occur from proposed activities. Federal agencies must consider such issues during the NEPA decision-making process. Section 2.1 discusses the issues, as those issues relate to the possible implementation of the alternative approaches to meeting the need for action.

[4]For administrative purposes, the WS program in South Dakota is part of the WS program in North Dakota, which forms the North Dakota/South Dakota WS program. As discussed in Section 1.4, the WS program only provides limited assistance within South Dakota because the SDGFP implements its own program to manage wildlife damage.

To meet the need for action identified in Section 1.4 and to address the identified issues discussed in Section 2.1, the WS program in South Dakota developed and considered several alternative approaches (see Section 2.2). After consideration of the need for action and the issues, WS identified two alternative approaches that WS will carry forward for further evaluation in Chapter 3. Section 2.2.1 discusses the two alternative approaches that WS could implement to meet the need for action. Section 2.2.2 also discusses alternatives considered but not analyzed in detail and provides WS' rationale for not considering those alternative approaches in detail within this EA. In addition, Section 2.3 discusses the Standard Operating Procedures (SOPs) that WS would incorporate into the relevant alternatives.

2.1 ISSUES ASSOCIATED WITH MEETING THE NEED FOR ACTION

WS identified those issues discussed in Section 2.1.1 and Section 2.1.2 based on experience, previous EAs developed by WS, and public comments on those EAs. Section 2.1.1 discusses those issues that WS carries forward for further analysis in Chapter 3. Section 2.1.2 discusses those issues that WS identified and considered during the scoping process for this EA but did not analyze in detail for the reasons provided.

2.1.1 Issues Carried Forward for Further Analysis in Chapter 3

This section describes the issues that WS identified during the scoping process for this EA and that WS evaluates further in Section 3.2. Section 3.2 analyzes the environmental consequences of each alternative in comparison to determine the extent of actual or potential impacts on the issues discussed in this section.

Issue 1 - Effects on the Coyote and Red Fox Populations Associated with Meeting the Need for Action

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 actions of WS to manage damage caused by predators (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 species, including the potential effects of actions on the ability of people to harvest target 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 animals to the public, resource owners, or neighboring residents.

As identified in Section 1.4, the need for action associated with the WS program is whether to continue assisting the SDGFP with managing livestock predation associated with coyotes and red fox, including conducting aerial operations when a tribal entity seeks assistance from the SDGFP and/or WS. If WS continues to assist the SDGFP, WS could lethally remove coyotes and/or red fox using a shotgun from aircraft to alleviate livestock predation. Therefore, a concern is the potential impacts lethal removal could have on the populations of coyotes and red fox if WS continues to provide assistance. The potential effects of implementing the alternative approaches on this issue occur in Section 3.2.1.

Issue 2 - Effects on Non-target Species Populations, Including T&E Species

Another common concern is the potential effects of proposed activities on non-target species, including threatened or endangered species. For example, what effects might occur from aerial overflights on non-target species. Another example would be the potential for misidentifying an animal from an aircraft. Section 3.2.2 of this EA discusses the potential effects of the alternatives on this issue.

Issue 3 - Effects of Damage Management Methods on Human 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. As in all other uses of aircraft, the aerial operations conducted by WS may result in an accident that could cause human injuries or fatalities. Section 3.2.3 of this EA discusses the potential effects of the alternatives on this issue.

2.1.2 Issues Considered But Not Analyzed Further in Chapter 3 for the Reasons Provided

WS identified additional issues during the scoping process of this EA. WS considered those additional issues but a detailed analysis did not occur and WS did not carry those issues forward for further discussion in Chapter 3. Discussion of those additional issues and the reasons for not analyzing them in detail occur below.

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 to the economy in South Dakota. 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 South Dakota encompasses approximately 48.5 million acres of land (United States Census Bureau 2010). In South Dakota, there are approximately 2.6 million acres of federal property (Vincent et al. 2014). However, not all of the federal property in the State is open to public access. The SDGFP manages more than 281,000 acres in the State for wildlife habitat and public hunting (SDGFP 2017*b*). In 2016, the South Dakota Office of School and Public Lands had administrative authority over approximately 760,000 acres of state trust land that is generally open to public access unless otherwise limited by the entity leasing the land (South Dakota Office of School and Public Lands 2016). In total, less than 8% 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 South Dakota 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 aerial activities is a concern that WS identifies in Section 2.2.1 and evaluates in comparison amongst the alternatives in Section 3.2.3. Similarly, Section 2.1.1 and Section 3.2.1 address the potential effects from WS' activities on the public's aesthetic enjoyment of animals and the potential effects of WS' activities on consumptive and non-consumptive uses associated with wildlife (*e.g.*, hunting, wildlife watching).

As discussed further in Section 2.2.1, the WS program would only conduct activities when personnel of the SDGFP and/or a tribal entity requests such assistance and only after the landowner or manager signs a MOU, work initiation document, cooperative service field agreement, work plan, and/or a similar document allowing WS to conduct activities. On public lands, the WS program in South Dakota 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. For example, the WS program in South Dakota 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 that WS not conduct activities in 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.

In addition, public land management agencies do not generally close public land areas while WS' personnel conduct activities or because of WS' activities. 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 3.2.3 of this EA evaluates the potential threats to human health and safety associated with conducting aerial operations to alleviate livestock predation caused by coyotes and/or red fox. Similarly, Section 3.2.1 and Section 3.2.2 address the potential effects of the proposed activities on the public's aesthetic enjoyment of animals and the potential effects on consumptive and non-consumptive uses associated with wildlife.

Concerns that WS' Pilots Might Unknowingly Conduct Activities on Properties without Permission

WS identified a concern that, during low-level flights, pilots could unknowingly conduct activities on properties where the property owner and/or manager have not authorized WS to conduct aerial activities. WS is aware that it is sometimes difficult to determine land ownership and boundary lines; however, WS' pilots and crewmembers would make diligent efforts to ensure that they do not conduct activities on properties where they do not have permission to conduct low-level flights. WS' pilots would use aerial maps with property boundaries and geospatial mapping tools (*e.g.*, Global Positioning Systems, Geographical Information System mapping technology) to ensure they only conduct activities on properties where the landowner and/or manager has signed the appropriate agreements allowing for activities to occur. WS' pilots are required to conduct aerial operations in conjunction with a ground crew. Ground crews would consist of personnel from the SDGFP. If aerial activities were occurring on properties owned and/or managed by a tribal entity, ground crews could consist of personnel from the SDGFP, personnel from WS, and/or personnel from tribal entities. Ground crews would consist of personnel who are familiar with property boundaries and can direct WS' pilots during low-level flights. Two-way radio communications between the pilot and the ground crew would be continuous (*i.e.*, radios continually on and monitored). Therefore, WS did not consider this issue in detail.

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

Aerial operations that WS could conduct to manage livestock predation would not cause major ground disturbance, would not cause any physical destruction or damage to property, would not cause any alterations of property, wildlife habitat, or landscapes, and would not involve the sale, lease, or transfer of ownership of any property. Conducting aerial operations at or in close proximity to historic or cultural sites for the purposes of removing coyotes and/or red fox would have the potential for audible effects on the use and enjoyment of the historic property. However, WS would only use such methods at a historic site after the property owner or manager signed a MOU, work initiation document, work plan, or a similar document allowing WS to conduct aerial operations on their property. A built-in minimization factor for this issue is that aerial operations 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 effects. WS would conduct site-specific consultation as required by the Section 106 of the NHPA, as necessary, in those types of situations.

In addition, the WS program in South Dakota 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 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 the 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, game production areas, national grasslands, recreation areas, wilderness areas, and state forest land. 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 only conduct activities on those areas after receiving a request from the SDGFP and would only conduct activities after the appropriate land management agency signs an MOU, work initiation document, work plan, or similar document allowing aerial activities to occur on those areas. 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. In addition, activities would only occur on land owned and/or managed by a tribe after the SDGFP and/or WS received a request for such assistance from the appropriate tribal entity.

If WS assisted the SDGFP, WS could conduct activities on areas designated as Wilderness Areas, Wilderness Study Areas, and other special management areas when allowed under the provisions of the specific legislation for those areas and as specified in MOUs between WS and the land management agencies. The Wilderness Act does not prohibit activities to manage wildlife damage within designated wilderness areas. With certain exceptions, the Wilderness Act prohibits using motorized equipment and motorized vehicles on designated areas, including the landing of aircraft. WS would continue to coordinate activities with appropriate state and federal land managers to ensure activities conducted by WS on properties under their jurisdiction were consistent with MOUs, work plans, management plans, and were consistent with current legislation for those areas.

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

Based on other scoping processes, 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 South Dakota occurs at the discretion of the property owner without involvement from WS or any activities conducted by WS. Therefore, damage management activities conducted by WS do not automatically trigger livestock grazing, 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 South Dakota, whether WS provides such assistance or not. Because federal agencies do not have the authority to regulate private land livestock grazing, such grazing and its effects are part of the existing human environment (*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. The SDGFP has and continues to conduct activities to manage wildlife damage in the State, including predation on livestock associated with coyotes and red fox. In the absence of any involvement by WS, livestock owners, land managers, and/or the SDGFP 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 discontinue. Some of those producers would likely sell their properties to other producers that may have a better economic ability to withstand predation losses.

Livestock grazing and damage management activities conducted by non-federal entities do not have to comply with the requirements and provisions of the NEPA and would represent the environmental status quo for the human environment in the absence of predation management assistance by WS. Federal environmental laws that govern federal agencies, such as the NEPA and the consultation requirements of Section 7 of the ESA, do not govern or restrict activities to manage animal damage conducted by private or non-federal entities. The only livestock grazing activities that are subject to the requirements of the NEPA would be those that federal land management agencies authorize to occur on federal lands, such as the Bureau of Land Management or the 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 from the Use of Lead Ammunition in Shotguns

Questions have arisen about the deposition of lead into the environment from ammunition used in shotguns to remove coyotes and/or red fox. 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). Deposition of lead into soil could occur if, during the use of a shotgun, the pellets passed through a coyote or red fox, 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 United States Environmental Protection Agency (*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 livestock predation using shotguns, as well as most other forms of dry land small game hunting in general, lead contamination from such sources would be minimal to nonexistent.

Because those coyotes and/or red fox removed by WS using shotguns could be lethally removed by the entities experiencing damage using the same method in the absence of WS' involvement, WS' assistance with removing coyotes and/or red fox would not be additive to the environmental status quo. The proficiency training received by WS' employees in shotgun use and accuracy would increase the likelihood that coyotes and/or red fox 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. 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.

Effects of Activities on Soils, Water, and Air Quality

The implementation of those alternative approaches discussed in Section 2.2.1 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. 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 2.2.1 would not occur in aquatic systems or cause changes in the flow, quantity, or storage of water resources. The use and storage of methods by WS' personnel would also follow WS' directives, including WS Directive 2.210, WS Directive 2.601, WS Directive 2.605, WS Directive 2.615, and WS Directive 2.620.

Aerial wildlife operations, like any other flying, may result in an accident. WS' pilots and crewmembers receive training and have experience to recognize the circumstances that lead to accidents. The national WS Aviation Program has increased its emphasis on safety, including funding for training, the establishment of a WS Flight Training Center, and annual recurring training for all pilots. In addition, WS has developed a comprehensive Aviation Operations and Safety Manual that provides guidance to WS' personnel when conducting aerial operations. 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; thus, the risk of catastrophic ground fires caused by an aircraft accident is exceedingly low.

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.

Petroleum products degrade through volatilization and bacterial action, particularly when exposed to oxygen (United States Environmental Protection Agency 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 United States Environmental Protection Agency guidelines provide for *"natural attenuation"* or volatilization and biodegradation in some situations to mitigate environmental hazards (United States Environmental Protection Agency 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 environmental damage from such accidents is exceedingly low.

Currently, the two principal types of fuel used in aviation today are aviation gasoline (commonly referred to as avgas) and jet fuel. According to the Federal Aviation Administration, aviation gasoline is the only transportation fuel that still contains a lead additive (Federal Aviation Administration 2017). Jet fuel does not contain a lead additive. The helicopters that WS could use to manage livestock predation associated with coyotes and/or red fox in South Dakota would use jet fuel, which does not contain lead. However, the airplanes that WS could use would use aviation gasoline, which does contain a lead additive. The Federal Aviation Administration (2017) stated, "[Aviation gasoline] *emissions have become the largest contributor to the relatively low levels of lead emissions produced in* [the United States]."

In consultation with the Federal Aviation Administration, the United States Environmental Protection Agency has the authority to regulate aircraft emissions under the Clean Air Act, including lead emissions from the use of aviation gasoline. When the United States Environmental Protection Agency sets standards for aircraft emissions, the Clean Air Act specifies that the United States Environmental Protection Agency and the Federal Aviation Administration must consider the time needed to develop required technology, consider cost, and must not adversely affect aircraft safety or noise (Federal Aviation Administration 2017).

In 2006, an environmental advocacy organization petitioned the United States Environmental Protection Agency to find that lead emissions from airplanes using aviation gasoline containing lead additives contribute to lead air pollution that may endanger public health or welfare. The same environmental advocacy organization petitioned the United States Environmental Protection Agency again in 2014 and urged the United States Environmental Protection Agency to make an endangerment finding regarding lead emissions from aviation gasoline. Despite the petitions, the United States Environmental Protection Agency continues to indicate that more data and findings are need to make a judgment on whether lead emissions from aviation gasoline are a danger to public health. Pursuant to Section 231 of the Clean Air Act, the United States Environmental Protection Agency is currently conducting proceedings regarding whether lead emissions from piston-engine general aviation aircraft that use aviation gasoline cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. In addition, the Federal Aviation Administration is supporting research of alternative fuels to replace aviation gasoline that contain lead additives. The Federal Aviation Administration anticipates issuing final test reports on alternative fuels to replace aviation gasoline that contain lead additives by the end of 2018 (Federal Aviation Administration 2017). The Federal Aviation Administration is committed to developing an alternative fuel or fuels for use in airplanes and the United States Environmental Protection Agency continues to proceed with investigations regarding whether lead emissions from airplanes using aviation gasoline cause or contribute to air pollution that may endanger the public.

In addition, in the absence of aerial operations assistance by WS, the SDGFP would likely continue with aerial operations to some or a large degree by contracting services of private pilots and airplanes, or by hiring one or more pilots and leasing or procuring a similar number of airplanes (K. Fisk, SDGFP, pers. comm. 2017). When the national WS program suspended all aerial operations to conduct a safety review following an aircraft accident in 2017, which included suspending WS' aerial operations in South Dakota, the SDGFP hired a private pilot to conduct aerial operations in the State (Fisk 2018). Consequently, the WS program in South Dakota does not expect the alternative approaches discussed in Section 2.2.1 to significantly change the environmental status quo with respect to 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.

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 will 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 United States Environmental Protection Agency (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). Sheikh et al. (2007) stated, "*Wildlife species can be affected by several climatic variables such as increasing temperatures, changes in precipitation, and extreme weather events*". Sheikh et al. (2007) further state that changes in climate could benefit some species of wildlife.

The impact of climate change on wildlife and their habitats is of increasing concern to land managers, biologists, and members of the public. Coyotes and red fox are abundant across a wide range of climate conditions and may be relatively resilient to climatic change. However, 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, WS has developed adaptive management strategies, including SOPs, and built in measures that allow WS and other agencies to monitor for and adjust to impacts of ongoing changes in the affected environment (see Section 2.3.1 and Section 2.3.2).

If the WS program selected an alternative approach to meeting the need for action that allows the program in South Dakota to provide assistance (see Section 2.2.1), WS would implement SOPs to monitor activities (see Section 2.3). WS would monitor activities in context of the issues analyzed in detail to determine if the need for action and the associated impacts remain within the parameters established and analyzed in this EA. In addition, the activities that WS could conduct would only occur after the SDGFP and/or a tribal entity determines WS' assistance was required. The mission of the SDGFP is to provide "*…sustainable outdoor recreational opportunities through responsible management of our state's parks, fisheries and wildlife by fostering partnerships, cultivating stewardship and safely connecting people with the outdoors*" (SDGFP 2017*a*).

Therefore, coordinating activities between WS, the SDGFP, and/or a tribal entity and WS only conducting activities when the SDGFP and/or a tribal entity requests WS' assistance would ensure the SDGFP and/or the tribal entity had the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations. As part of those coordinated activities, WS would submit annual activity reports to the SDGFP to aid with the ongoing monitoring efforts of the SDGFP. If WS determines that a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts warrant a new or additional analysis, WS would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS 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 South Dakota 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. Should this monitoring and analysis determine it to be necessary, WS could adjust activities to assure that its actions do not significantly contribute to changes in the environmental status quo that occur because of climate change.

Greenhouse Gas Emissions by the WS Program

Under the alternative approaches intended to meet the need for action discussed in Section 2.2, the WS program in South Dakota 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 an office, traveling to an airfield, and from flight 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 (see pages 266 and 267 in USDA 2015). The analysis estimated effects of vehicle, aircraft, office, and ATV use by WS for federal fiscal year (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 the CEQ for actions requiring detailed review of impacts on greenhouse gas emissions. The activities that WS could conduct under the alternative approaches discussed in Section 2.2.1 would have negligible cumulative effects on atmospheric conditions, including the global climate.

Concern about the Irreversible and Irretrievable Commitment of Resources from WS' Activities

Other than relatively minor uses of fuels for vehicles and aircraft, electricity for office operations, electricity for aircraft hangars, and some components associated with ammunition (*e.g*., black powder, shot), no irreversible or irretrievable commitments of resources result from the WS program.

Humaneness and Animal Welfare Concerns of Methods

The issue of humaneness and animal welfare, as it relates to taking the life of an animal, is an important but very complex concept that people can interpret in a variety of ways. The American Veterinary Medical Association (AVMA) defines euthanasia as "…*ending the life of an individual animal in a way that minimizes or eliminates pain and distress*" (AVMA 2013). 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."*

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. The challenge in coping with this issue is how to achieve the least amount of animal suffering. Suffering has previously been described by the AVMA as a *"…highly unpleasant emotional response usually associated with pain and distress"* (AVMA 1987); however, suffering *"…can occur without pain…,"* and *"…pain can occur without suffering…"* because suffering carries with it the implication of occurring over time, a case could be made for *"…little or no suffering where death comes immediately…"* (California Department of Fish and Game 1991). 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.

When evaluating humaneness, defining pain appears to be a greater challenge than that of suffering. Pain obviously occurs in animals. Altered physiology and behavior can be indicators of pain; however, pain experienced by individual animals probably ranges from little or no pain to considerable pain (California Department of Fish and Game 1991).

The AVMA has previously stated, "*...euthanasia is the act of inducing humane death in an animal*" and "*... the technique should minimize any stress and anxiety experienced by the animal prior to unconsciousness*" (Beaver et al. 2001). In addition, the AVMA has previously stated that "[f]*or wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but terms such as killing, collecting, or harvesting, recognizing that a distress-free death may not be possible*" (Beaver et al. 2001).

The challenge would be how to achieve the least amount of animal suffering because 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). Therefore, the goal of WS would be to address coyotes and/or red fox using shotguns in the most humane way possible that minimizes the stress and pain to the animal by achieving the least amount of suffering. In accordance with WS Directive 1.301 and WS Directive 2.505, WS' personnel will exhibit a high level of respect and professionalism when taking the life of an animal regardless of the method. Therefore, WS did not consider this issue further in Chapter 3.

2.2 DESCRIPTION OF THE ALTERNATIVES

Section 2.2 discusses those alternative approaches that WS identified during the scoping process for this EA. WS developed the alternative approaches based on the need for action. The need for action identified by WS is whether to continue assisting the SDGFP by incorporating WS' aerial operations into the program administered by the SDGFP to manage wildlife damage in the State, which could include conducting aerial operations on land owned and/or managed by a tribe when the appropriate tribal entity requests such assistance (see Section 1.4). WS also developed the alternative approaches to address those issues identified in Section 2.1. Section 2.2.1 discusses those alternative approaches WS will consider in detail within Chapter 3 of this EA. Chapter 3 analyzes the environmental consequences of each alternative identified in Section 2.2.1 as those alternatives relate to the identified issues. Section 2.2.2 discusses those alternative approaches that WS identified but WS did not analyze those alternatives in detail within Chapter 3 for the reasons provided in the description of each alternative. Section 1.5 also discusses approaches that would be outside the scope of this EA given the need for action.

2.2.1 Alternatives Carried Forward for Further Analysis in Chapter 3

As discussed in Section 1.1 and Section 1.4, people experiencing damage or threats of damage associated with wildlife often seek assistance from other entities to alleviate that damage or to prevent damage from occurring. The WS program is the lead federal agency responsible for managing conflicts between people and wildlife (see Section 1.2 and Section 1.4). In South Dakota, the SDGFP administers a program to manage wildlife damage within the State. As discussed in Section 1.4, the SDGFP has requested that WS incorporate its aircraft, pilots, and crewmembers into the damage management program administered by the SDGFP to reduce economic losses associated with coyotes and red fox killing livestock in the State. Assistance could include conducting aerial operations on land owned and/or managed by a tribe when the appropriate tribal entity requests such assistance from the SDGFP and/or from WS. Therefore, WS could decide to assist the SDGFP (see Alternative 1) or decide not to assist the SDGFP (see Alternative 2). Section 2.2.1 provides a description of how WS would implement those alternative approaches.

Alternative 1 - Continue to Incorporate WS' Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP (No Action/Proposed Action)

If WS implemented Alternative 1, WS would continue to incorporate aerial operations into the program administered by the SDGFP to alleviate predation on livestock associated with red fox and coyotes. WS would conduct aerial operations when personnel with the SDGFP and/or a tribal entity determine the use of a shotgun from an aircraft is an appropriate method to prevent or alleviate livestock predation associated with coyotes and/or red fox. In addition, WS would only conduct aerial operations after the appropriate landowner or manager signed an agreement allowing WS to use shotguns from aircraft on property they own or manage. WS would only conduct aerial operations to prevent or alleviate predation on livestock and only livestock predation associated with coyotes and/or red fox. Pursuant to current funding and agreements, WS would provide aircraft, which would include airplanes and/or helicopters, pilots, and additional crewmembers that use a shotgun from the aircraft to target coyotes and/or red fox. Funding for WS' activities could originate from federal, state, tribal, and/or private sources.

Alternative 2 – WS would no longer Incorporate Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP

If WS implemented Alternative 2, the WS program would no longer conduct any aerial operations to alleviate livestock predation associated with coyotes and/or red fox in South Dakota. WS would provide written notice to the SDGFP terminating any existing agreements between WS and the SDGFP relating to the integration of WS' aircraft and associated personnel into the program administered by the SDGFP to manage wildlife damage in the State. At the end of the termination process, the WS program would no longer conduct aerial operations to alleviate predation on livestock associated with coyotes and red fox in South Dakota in accordance with those agreements.

2.2.2 Alternatives Considered But Not Analyzed Further in Chapter 3 for the Reasons Provided

In addition to those alternatives discussed in Section 2.2.1, WS identified several additional alternative approaches to meeting the need for action. However, those alternatives will not receive detailed analysis in Chapter 3 for the reasons provided for each alternative. Those alternatives considered but not analyzed in detail include the following.

Implementation of Alternative 1 but WS' personnel would verify livestock predation before conducting activities

As described in Section 2.2.1, the implementation of Alternative 1 by WS would involve providing aerial operations after personnel with the SDGFP and/or a tribal entity requested such assistance when they deem aerial operations appropriate. Therefore, personnel with the SDGFP and/or a tribal entity would determine the need for aerial operations conducted by WS. However, if WS implemented this alternative, WS' personnel would independently verify livestock losses or threats of losses before conducting aerial operations. After receiving a request for assistance from personnel with the SDGFP and/or a tribal entity, WS' personnel would independently investigate to verify livestock losses or threats of losses on a property before conducting aerial operations.

WS did not consider this alternative further because personnel within the SDGFP receive training to identify wildlife damage and are capable of verifying livestock predation caused by coyotes and/or red fox. In addition, requiring WS' personnel to confirm livestock predation could unnecessarily delay assistance to livestock producers experiencing losses. Livestock losses can be economically burdensome to individual livestock producers and unnecessarily delaying assistance while WS' personnel also verify predation could lead to additional livestock losses. In addition, WS does not have the staff nor resources in South Dakota to investigate and confirm livestock losses across the State before conducting aerial operations.

Implementation of Alternative 1 but WS would only conduct aerial operations after recent livestock predation occurred

Managing damage proactively and reactively are the general approaches to alleviating damage cause by predators (Baker et al. 2008). If WS implemented this alternative, WS would implement Alternative 1; however, WS would only conduct aerial operations after recent livestock losses occurred (*i.e.*, reactive actions) and would not conduct aerial operations to reduce the likelihood of predation occurring at a future time based on historical livestock losses (*i.e.*, proactive actions). Proactive actions often involve situations where livestock losses have occurred historically and WS takes an action to prevent livestock losses from occurring in the future.

For example, a producer has cattle that produce calves in the spring. Last year, coyotes killed two calves and the producer contacted the SDGFP for assistance. Personnel with the SDGFP confirmed coyotes caused the calf losses and assists the producer to prevent further losses from occurring until the producer sells the calves or the calves reach sufficient size that they are too large for coyotes to prey upon them effectively. The actions that personnel with the SDGFP take to prevent further losses to the calves would be reactive actions. Before the calving season next spring, the producer contacts the SDGFP to express concern that coyotes are likely to kill calves again in the spring and requests the SDGFP conduct activities to prevent coyote predation before the calving season begins in the spring. In those situations, the SDGFP could provide assistance to the producer before the calving season begins based on the losses that occurred the previous year and the likelihood that losses could occur again if the SDGFP did not conduct activities to prevent the predation from occurring. Those actions taken by the SDGFP and WS' aerial operations (if requested) to prevent further predation based on historical livestock losses would be proactive actions. 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).

Wagner and Conover (1999) concluded that removing coyotes from lambing grounds in Utah three to six months prior to the arrival of adult sheep reduced future predation rates of lambs. Till and Knowlton (1983) indicated that livestock depredation in the spring and summer was caused by territorial adult coyotes with pups to feed. Findings by Bromley and Gese (2001*a*, 2001*b*) further support the conclusions of Till and Knowlton (1983) and Wagner and Conover (1999). 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. Seidler and Gese (2012) found similar results. Wagner and Conover (1999) stated, "*Coyote hunting during the early breeding season may disrupt the formation of* [coyote breeding] *pairs that can produce young during the subsequent summer. Although continued coyote immigration could result in precontrol coyote densities by the time sheep arrive, lamb losses would still be lower because these new coyotes arrived too late to mate, so there would still be few coyotes with pups in the population*."

Livestock losses due to predation can be economically burdensome to farmers and ranchers (Baker et al. 2008). Livestock producers generally do not wait for losses to become economically burdensome before conducting damage management activities and/or requesting assistance from the SDGFP or other entities. Therefore, livestock producers often attempt to act before such losses become unacceptable. If WS implemented this alternative, the SDGFP could terminate the cooperative program with WS, and then conduct reactive and proactive coyote and red fox removals anyway. If that occurred, implementation of this alternative would likely be similar to implementing Alternative 2 (no WS aerial operations assistance). The SDGFP could also continue the cooperative program with WS when conducting reactive aerial operations after recent livestock losses but implement their own program or hire other entities to conduct proactive aerial operations. Therefore, WS did not carry this alternative forward for further analysis in Chapter 3.

Implementation of Alternative 1 but WS would only conduct aerial operations after verification of non-lethal method use

The implementation of this alternative would require WS' personnel verify that a livestock producer was using non-lethal methods or require the SDGFP to provide verification of the use of non-lethal methods before WS would agree to conduct aerial operations to alleviate livestock predation associated coyotes and/or red fox. Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to seeking further assistance. Livestock producers use many non-lethal methods to reduce predation (*e.g*., see 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).

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). From 2000 to 2015, the number of cattle operations that used non-lethal methods to manage livestock predation by predators increased from 3.1% in 2000 to 19.0% in 2015 (APHIS Veterinary Services 2017). For cattle operations that spent money on managing livestock predation by predators during 2015, the average amount spent on non-lethal methods was approximately $3,000 (APHIS Veterinary Services 2017). The primary non-lethal method employed by cattle producers in South Dakota was the use of guard animals (NASS 2011). Producers also reported using additional non-lethal methods, including culling, frequent checks, livestock carcass removal, exclusion fencing, fright tactics, herding, night penning, and other non-lethal methods (NASS 2011). Sheep producers in South Dakota also use non-lethal methods to prevent sheep losses. The APHIS Veterinary Services (2015) reported that sheep producers in South Dakota used guard dogs, llamas, donkeys, fencing, lamb shed, herding, night penning, fright tactics, removing carrion, culling, changing bedding, frequent checks, altered breeding season, and other non-lethal methods to prevent predation.

No standard exists to determine requester diligence in applying non-lethal methods, nor are there any standards to determine how many non-lethal applications are necessary before the initiation of lethal methods. Thus, WS and/or the SDGFP would have to develop a standard or would only evaluate the presence or absence of non-lethal methods. Because many livestock producers use non-lethal methods but continue to experience livestock losses associated with coyotes and/or red fox and because there is no standard that exists for the use of non-lethal methods, WS did not carry this alternative forward for further analysis in Chapter 3.

Implementation of Alternative 1 but WS would Require Cooperators Pay All of the Cost of Aerial Operations (no taxpayer money)

Under this alternative, WS would require the entity seeking assistance with managing predation caused by coyotes and/or red fox provide all necessary funding for aerial operations. Funding for WS' activities could occur from federal appropriations, through state funding, through funding from a tribal entity, and/or through cooperative funding. In those cases where WS receives funding to conduct activities, federal, state, tribal, and/or 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 because 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. Therefore, WS did not consider this alternative in detail.

Implementation of Alternative 1 after WS establishes a Loss Threshold for Conducting Activities

An alternative identified through WS' implementation of the NEPA processes in other similar programs 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. Some people express a concern that individual perceptions of risk from coyotes and/or red fox could be disproportionately high to actual risk, which could potentially result in a request to have a coyote and/or red fox lethally removed just because someone saw the animal near their livestock. The primary concern is that WS may initiate activities in response to a perceived but unsubstantiated threat and that perceived threats of loss are not sufficient to trigger the need to conduct aerial operations.

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, removing predators 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.

In some cases, cooperators likely tolerate some damage and economic loss until the damage reaches a threshold where the damage becomes an intolerable economic burden. The ability to tolerate predation losses differs among cooperators and damage situations. In some cases, any loss in value of a resource caused by coyotes and/or red fox could be financially burdensome to a livestock producer. Therefore, WS did not consider this alternative further in Chapter 3.

WS should Conduct More Rigorous Scientific Testing to determine if Aerial Operations are 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 authors recommended 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 National Wildlife Research Center (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 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 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 switchback 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.

For example, one of the study designs questioned by Treves et al. (2016) was the effects of preventative coyote removal on sheep losses caused by coyote predation published by Wagner and Conover (1999). 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 conducted by Wagner and Conover (1999) 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, cable devices, and M-44 devices - also a dependent variable) during the subsequent summer. Treves et al. (2016) mistakenly characterize use of traps, cable devices, and M-44 devices as independent variables, which indicates a fundamental inattentiveness to the details of the study. This error led Treves et al. (2016) 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, Wagner and Conover (1999) predicted the 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, cable devices, 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 stated 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 by Wagner and Conover (1999) 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.

WS agrees that scientifically sound principles must form the basis for the tools and techniques that people use to manage wildlife damage. 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[5].

WS has determined that detailed analysis of this alternative would not provide substantive new information to aid the decision-maker. The WS program based this determination on the deficiencies of the paper published by Treves et al. (2016). Ultimately, this alternative would be identical to Alternative 1 and Alternative 2 because WS would implement Alternative 2 during the research phase of this alternative. Then, depending on the outcome of the research, could implement Alternative 1 or continue to implement Alternative 2.

2.3 STANDARD OPERATING PROCEDURES FOR ALTERNATIVE 1

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 South Dakota uses many such SOPs. If WS continued to implement Alternative 1, WS' personnel would incorporate those SOPs into activities when conducting activities to alleviate livestock predation associated coyotes and/or red fox. Most SOPs abate specific issues while some are more general and relate to the overall program. If WS implemented Alternative 2, the WS program in South Dakota would no longer conduct aerial operations; therefore, SOPs would not be applicable.

2.3.1 Some Key SOPs Pertinent to Conducting Aerial Operations in the State

- WS' personnel would follow the WS Policy Manual when conducting official activities pursuant to WS Directive 1.101.

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

- WS' personnel would follow the ethical guidelines in WS Directive 1.301 to promote and preserve the professional standards of the WS program.

- WS personnel would comply with applicable federal, state, and local laws and regulations (see WS Directive 2.210).

- WS' employees would adhere to safety requirements and use appropriate personal protective equipment pursuant to WS Directive 2.601.

- All personnel who use shotguns would follow the guidelines for using firearms and would receive training according to 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, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137.

- To ensure adequate documentation of WS' activities, WS' personnel would document work activities in accordance with WS Directive 4.205.

- WS would continue to coordinate activities with appropriate state land managers, federal land manager, and tribal entities to ensure activities conducted by WS on properties under their jurisdiction were consistent with MOUs, work plans, cooperative service field agreements, and management plans. Coordination would occur within timeframes consistent with MOUs signed by WS and the state or federal land management agency and/or tribal entity. In most cases, coordination meetings would occur at least annually.

2.3.2 SOPs Specific to the Issues

Several SOPs would be applicable to Alternative 1 and the issues identified in Section 2.1.1. This section lists the SOPs for each of the issues identified in Section 2.1.1 that WS' personnel would incorporate into aerial operations if WS implements Alternative 1.

Issue 1 - Effects on the Coyote and Red Fox Populations Associated with Meeting the Need for Action

- The removal of coyotes and/or red fox by WS would only occur when requested by the SDGFP and/or a tribal entity and only on properties where the landowner or manager agrees to allow aerial operations.

- WS' personnel would direct management actions toward localized populations, individuals, or groups of coyotes and/or red fox. WS would not conduct generalized population suppression across South Dakota, or even across major portions of the State.

- The WS program would monitor activities to ensure activities continued to occur pursuant to the Alternative 1.

- The WS program would document and report annual removal of coyotes and/or red fox to the SDGFP so the SDGFP has the opportunity to monitor the cumulative mortality of coyotes and red fox to meet management objectives and to assure those species do not become imperiled in the State.

Issue 2 - Effects on Non-target Species Populations, Including T&E Species

- When conducting aerial operations using a shotgun, identification of the target would occur prior to application.

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

- WS has consulted with the USFWS to evaluate activities to resolve livestock predation using aerial operations to ensure the protection of threatened or endangered species.

- WS would monitor activities to ensure activities do not negatively affect non-target species.

- WS' personnel would review all projects proposed for implementation for potential to take[6] bald eagles and golden eagles in accordance with the provisions of the Bald and Golden Eagle Protection Act (16 USC 668-668c). 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 (see 74 FR 46836-46837, 50 CFR 22.26, 50 CFR 22.27). WS would conduct aerial activities in accordance with the National Bald Eagle Management Guidelines.

Issue 3 - Effects of Damage Management Methods on Human Safety

- WS' personnel would conduct aerial operations professionally and in the safest manner possible.

- When conducting aerial operations, WS' personnel would consider 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).

- All WS' personnel would follow the policies and directives set forth in WS Directive 2.620, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137.

- WS would continue to coordinate activities with appropriate state land managers, federal land managers, and tribal authorities to ensure activities conducted by WS on properties under their jurisdiction were consistent with MOUs, work plans, cooperative service field agreements, and management plans. Coordination of WS' activities with land management agencies would help to identify areas of public lands with high use to minimize risks to human safety.

CHAPTER 3: ENVIRONMENTAL EFFECTS

Chapter 3 provides information needed for making informed decisions by comparing the environmental consequences of the two alternatives. Section 3.1 provides further discussion on how WS will evaluate significance as it relates to the NEPA. To determine if the real or potential effects are greater, lesser, or the same as the environmental baseline, Section 3.2 compares the environmental consequences of the two alternatives. A discussion occurs on the cumulative and unavoidable impacts, including direct and

[6] 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.

indirect effects, in relation to the issues for each of the alternatives. Impacts caused by implementation of an alternative approach and occur at the same time and place are direct effects. In contrast, impacts caused by implementing an alternative approach that occur later in time or further removed in distance, and are still reasonably foreseeable, are indirect effects. The analyses discuss the cumulative effects in relationship to each of the alternatives analyzed, with emphasis on potential cumulative effects from similar activities, and include summary analyses of potential cumulative impacts to target and non-target species, including T&E species, and threats to human health and safety.

3.1 EVALUATION OF SIGNIFICANCE

Section 3.2 evaluates the direct, indirect, and cumulative impacts associated with implementation of the two 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. When reviewing the context and intensity of the alternatives, WS considered the magnitude of the impact, the duration/frequency of the action, the likelihood of the impact, the geographic extent, the legal status, and conforming to statutes, regulations, and policies.

3.1.1 Magnitude of the Impact

The basis for determining the magnitude of an impact is the size, number, or relative amount of the impact (intensity). For example, the analysis that occurs in Section 3.2 measures the known number of individual animals lethally removed annually in relation to the abundance of that animal to determine the magnitude of impact to that species' population from the lethal removal of those animals. 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 would be qualitative.

3.1.2 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 coyote and red fox behavior would affect the duration and frequency of activities conducted by WS if WS continued to implement Alternative 1. 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 coyotes and red fox that are causing damage. For instance, the lethal removal of red fox that continue to depredate may be very infrequent if non-lethal techniques prevent additional red fox 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.

3.1.3 Likelihood of the Impact

This factor can relate to the likelihood that there would be a need for a particular damage management action, and to the likelihood that an impact may occur because of a damage management action. For example, most requests to alleviate livestock predation are associated with coyotes; therefore, the likelihood that WS could address coyotes to reduce livestock depredation may be relatively high. WS receives very few requests for assistance involving red fox; therefore, the need to address red fox 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.

3.1.4 Geographic Extent

If WS continues to implement Alternative 1, aerial operations could continue to occur in areas of South Dakota where personnel of the SDGFP and/or a tribal entity request such assistance and where agreements for such actions are in place. Requests for assistance are likely to occur in rural areas of the State where livestock and agriculture production occurs. South Dakota encompasses about 75,811 square miles of land area (United States Census Bureau 2010), which equates to 48,519,040 acres. However, agreements to conduct aerial operations to address coyote and red fox predation on livestock comprise a small portion of the land area in the State and not all properties need assistance with aerial operations in any given year. Between FY 2012 and FY 2016, WS conducted aerial operations on 3.9% of the total land area of the State annually. Additionally, WS generally only conducts activities on a small portion of the land acres allowed under a MOU, work initiation document, cooperative service field agreement, or another comparable document. For example, a landowner may allow aerial operations to occur on the 100 acres they own but WS' personnel might only conducted activities on 10 acres of the property.

3.1.5 Legal Status

The legal status of an affected resource would be a contextual consideration. Legal status may range from protected by federal law or state law to no protection. For example, federal law protects species of wildlife listed as threatened or endangered pursuant to the ESA, while state laws may protect or restrict activities associated with wildlife resources within a State.

3.1.6 Conformance with Statutes, Regulations, and Policies

Statutes, regulations, and policies provide contextual information in the analysis. Compliance with applicable statutes, regulations, and policies can also serve as mitigation to ensure that certain types of adverse effects on the environment do not occur.

3.2 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 and the SDGFP.

3.2.1 Issue 1 - Effects on the Coyote and Red Fox Populations Associated with Meeting the Need for Action

A common issue is whether conducting activities to manage damage caused by wildlife would adversely affect the populations of target wildlife species, especially when entities apply lethal methods. 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 impacts association with human activities on such populations. As discussed in Section 1.4, the need for action associated with the WS program is whether to incorporate aerial operations to manage livestock predation caused by coyotes and/or red fox into the program of the SDGFP that assists people in the State with managing wildlife damage, including aerial activities requested by a tribal entity. The SDGFP has the authority to manage populations of resident wildlife species, such as coyotes and red fox, 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 coyotes and red fox is the management direction established by the SDGFP. Federal actions that are in accordance with state management have no effect on the status quo. The analysis of potential effects on the coyote and red fox populations in South Dakota from the continued implementation of Alternative 1, or from WS implementing Alternative 2, occurs below for each of those alternatives.

Alternative 1 - Continue to Incorporate WS' Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP (No Action/Proposed Action)

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. To evaluate the potential direct, indirect, and cumulative effects associated with implementing Alternative 1, the magnitude associated with lethally removing coyotes and/or red fox to alleviate livestock predation occurs below for each species.

COYOTE POPULATION DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS

Coyotes are a familiar species of mammal to most people. Their coloration is blended, primarily gray mixed with a reddish tint. Coyotes have long, rusty or yellowish legs with dark vertical lines on the lower foreleg. They are similar in appearance to the gray wolf (*Canis lupus*) and the red wolf (*Canis rufus*) (Bekoff and Gese 2003). The coloration of coyotes varies greatly from nearly black to red to nearly white in some individuals and local populations. Most have dark or black guard hairs over their back and tail (Green et al. 1994). In South Dakota, Miller (1995*a*) stated, "…*coyotes from the southern part of the state mostly have a reddish tint with a buff colored belly. In the northwestern part of the state and badlands area, they appear more white in color with a pure white belly*". The size of coyotes varies from 20 to 40 pounds (9 to 18 kg) (Voigt and Berg 1987, Miller 1995*a*).

Coyotes often include many items in their diet. Rabbits (*Sylvilagus* spp.) 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).

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 around 1900 to 1920, primarily because of changes in habitat, loss of wolves, and possible introductions into other parts of the country where they previously did not occur (Voigt and Berg 1987, Bekoff and Gese 2003). Now, all eastern states and Canadian provinces have at least a small population of coyotes (Voigt and Berg 1987, Bekoff and Gese 2003). 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 can also appear in the suburbs of major cities (Green et al. 1994, Bekoff and Gese 2003).

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 can contain 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). Each coyote territory may have several nonbreeding helpers at the den during whelping; thus, each defended coyote territory may have more than just a pair of coyotes (Allen et al. 1987, Bekoff and Wells 1982). Messier and Barrette (1982) reported that from November through April, 35% of the coyotes were in groups of three to five animals. In southeastern Colorado, Gese et al.

(1988) reported that 40% of territorial coyotes occurred in groups of two while 53% occurred in groups of three to five coyotes. In addition, Gese et al. (1988) found that 78% of the coyote population within their study area was territorial (used one unique area) while 22% of the coyotes were non-territorial (displayed nomadic movements over large areas).

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). A number of factors can influence coyote breeding, which can cause large annual variations in the 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. In South Dakota, Miller (1995*a*) indicated that breeding generally occurs in February and early March with litters averaging five to seven pups arriving in April and early May. Coyotes will sometimes breed with domestic dogs (Miller 1995*a*, Bekoff and Gese 2003).

The coyote is probably the most extensively studied carnivore (Bekoff and Gese 2003) with considerable research focusing on population dynamics. 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). However, methods for estimating carnivore populations are often crude and can produce estimates with broad confidence intervals (Crawford et al. 1993). In addition, the cost to determine absolute coyote densities accurately over large areas can be prohibitive (Connolly 1992). 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. 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). For example, Roy and Dorrance (1985) established a positive relationship between coyote densities in mid-late winter and the availability of dead livestock. 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. Coyote densities are generally 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).

Coyote densities in South Dakota are currently not available and, as discussed previously, densities likely vary based on several factors (*e.g.*, habitat, season, food abundance). Miller (1995*a*) stated, "*Prior to the early 1980's, coyotes were common only in western South Dakota and in the counties bordering the Missouri River on its eastern side. Since that time, in response to high coyote populations in the west, coyotes have expanded their range to include the entire state*." The highest coyote densities in the State likely occur along the major river drainages (Miller 1995*a*). Miller (1995*a*) estimated the statewide coyote population to be 70,000 to 75,000 coyotes, which is an average of one coyote per square mile. To evaluate the direct and cumulative effects associated with implementing Alternative 1, the analyses will use a statewide population estimated at 70,000 coyotes, which is the lower population estimate provided by Miller (1995*a*). The actual coyote population or more recent coyote population estimates for South Dakota are currently not available.

Direct effects on the coyote population in South Dakota associated with implementing Alternative 1

As discussed previously, the SDGFP continues to implement a statewide program to assist South Dakota residents with managing damage caused by wildlife, including damage and threats of damage associated with coyotes. As part of that program to manage wildlife damage, WS, at the request of the SDGFP, conducted aerial operations to remove coyotes using shotguns to alleviate livestock predation. Table 3.1 shows the number of coyotes the SDGFP lethally removed by year from 2011 through 2016 to alleviate damage, which includes the number of coyotes lethally removed by WS during aerial operations. Between 2011 and 2016, the program to manage wildlife damage administered by the SDGFP lethally removed an average of 6,402 coyotes per year in the State to alleviate damage or threats of damage, which includes those coyotes lethally removed by WS during aerial operations to alleviate livestock predation at the request of the SDGFP. The highest annual removal of coyotes occurred in 2016 when the program administered by the SDGFP to alleviate wildlife damage lethally removed 8,531 coyotes.

From 2011 through 2016, the WS program lethally removed an average of 2,409 coyotes per year in the State using a shotgun from an aircraft. WS lethally removed coyotes from an aircraft only when personnel from the SDGFP requested assistance from WS and only if the property owner or manager allowed WS to conduct aerial activities on their property. From 2011 through 2016, WS' annual removal of coyotes has ranged from 1,803 to 3,217 coyotes lethally removed. Of the 6,402 coyotes lethally removed per year from 2011 through 2016 by the damage program administered by the SDGFP (see Table 3.1), 37.6% (2,409 coyotes) of the total removal occurred by WS during aerial operations. Of the total number of coyotes lethally removed by the wildlife damage program administered by the SDGFP, WS' removal during aerial operations has ranged from 28.3% to 50.4% of the total number of coyotes lethally removed.

As shown in Table 3.1, from 2011 through 2016, the direct effects on the statewide coyote population associated with the program implemented by the SDGFP in the State to alleviate wildlife damage (including activities that WS could conduct) has ranged from 6.9% to 12.2% annually if the statewide coyote population was 70,000 coyotes. The average annual removal of 6,402 coyotes by the SDGFP from 2011 through 2016 represented 9.2% of a statewide coyote population estimated at 70,000 coyotes. Based on the limited removal that occurs by the SDGFP to alleviate damage associated with coyotes when compared to the estimated statewide coyote population, the activities of the SDGFP (including activities that WS could conduct) would not limit the ability of people to harvest coyotes in the State.

Table 3.1 – Lethal removal of coyotes in South Dakota by the SDGFP, 2011 - 2016

Year	Wildlife Damage Program Removal†	Estimated Statewide Coyote Population‡	Wildlife Damage Program % of Population
2011	4,847	**70,000**	6.9%
2012	6,375	**70,000**	9.1%
2013	6,023	**70,000**	8.6%
2014	5,173	**70,000**	7.4%
2015	7,462	**70,000**	10.7%
2016	8,531	**70,000**	12.2%
Annual Average*	**6,402**	**70,000**	**9.2%**

†Includes those coyotes lethally removed by the SDGFP to alleviate damage and those coyotes removed during aerial operations by WS

‡Estimated statewide coyote population based on the lowest population estimate provided by Miller (1995*a*)

*Annual average from 2011 through 2016

Overall, the activities of the SDGFP to alleviate coyote damage in the State and the use of shotguns from aircraft by WS to remove coyotes causing damage would not directly affect the statewide coyote population in the State based on the limited removal occurring when compared to the estimated statewide population. Although implementing Alternative 1 could result in a localized reduction in the number of coyotes at those locations where activities occur to alleviate coyote damage, the reduction would likely be short-term because compensatory reproduction would contribute to population recovery after removals. Gese (1998) found 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 can quickly replace the coyotes removed (Stoddart 1984).

If WS implements Alternative 1, conducting aerial operations as an integrated part of the program administered by the SDGFP to alleviate wildlife damage in the State would be occurring simultaneously, over time, with other natural processes and human generated changes that influence wildlife populations (*e.g.*, see Collins and Kays 2011). Those process and changes would be part of the cumulative effects occurring to the coyote population in South Dakota. A discussion of the cumulative effects on the coyote population in South Dakota that would be occurring simultaneously during the implementation of Alternative 1 occurs below.

Cumulative effects on the coyote population in South Dakota associated with implementing Alternative 1

Many natural processes and human generated changes would be occurring simultaneously during the implementation of Alternative 1 that could cumulatively affect the coyote population in South Dakota. Those natural processes and human generated changes could include:

- Natural mortality of coyotes
- Mortality through vehicle strikes and aircraft strikes
- Human-induced mortality from annual hunting and/or trapping seasons for coyotes
- Human-induced mortality of coyotes through private damage management activities
- Human and naturally induced alterations of wildlife habitat
- Annual and perennial cycles in coyote population densities

All those factors can play a role in the dynamics of coyote populations within the State. In addition to the annual mortality that occurs by the SDGFP to alleviate damage associated with coyotes, another known human-induced mortality factor is harvest during annual hunting and trapping seasons for coyotes in the State. In accordance with South Dakota Codified Law 41-1-1(11), the SDGFP classifies coyotes as "*fur-bearing animals*" within the State that people can harvest during hunting and trapping seasons. Pursuant to South Dakota Codified Law 41-8-20, people can harvest coyotes throughout the year (*i.e.*, no closed season) using legal firearms and traps with no limit on the number of coyotes that people can harvest. Table 3.2 shows the number of coyotes that hunters and trappers harvested in the State from 2011 through 2016. From 2011 through 2016, people issued a furbearer license[7] in the State harvested an average of 8,768 coyotes during the trapping season. Similarly, people harvested an average of 7,871 coyotes during

[7]The SDGFP can issue several different types of hunting and trapping licenses to people in the State depending on certain factors, such as season, activities, and species. A furbearer license is one type of license the SDGFP can issue a person, which allows that person to harvest many furbearing species in the State.

the hunting season in the State from 2011 through 2016. From 2011 through 2016, the highest annual harvest of coyotes occurred in 2012 when the SDGFP projected that people issued a furbearer license harvested 21,928 coyotes in the State. People issued other types of hunting and/or trapping licenses can also harvest coyotes in the State. The number of coyotes harvested by people issued other types of licenses in the State is not currently available; therefore, the harvest data for coyotes represents a minimum estimate.

Table 3.2 – Known lethal removal of coyotes in South Dakota by source, 2011 – 2016

Year	Harvest*		Wildlife Damage Program Removal†	TOTAL	Statewide Population‡	Cumulative Removal % of Population
	Trapping	Hunting				
2011	6,937	5,569	4,847	**17,353**	70,000	**24.8%**
2012	10,939	10,989	6,375	**28,303**	70,000	**40.4%**
2013	8,520	7,443	6,023	**21,986**	70,000	**31.4%**
2014	9,217	7,487	5,173	**21,877**	70,000	**31.3%**
2015	10,306	9,034	7,462	**26,802**	70,000	**38.3%**
2016	6,687	6,706	8,531	**21,924**	70,000	**31.3%**
Average**	**8,768**	**7,871**	**6,402**	**23,041**	**70,000**	**32.9%**

*Harvest estimate from people issued a furbearer license (people issued other types of licenses can also harvest coyotes); therefore, the harvest data represents minimal estimates.

†Includes those coyotes lethally removed by the SDGFP to alleviate damage and those coyotes removed during aerial operations by WS

‡Estimated statewide coyote population based on the lowest population estimate provided by Miller (1995*a*)

**Annual average from 2011 through 2016

As shown in Table 3.2, people in the State issued a furbearer license harvested an average of 16,639 coyotes and the SDGFP lethally removed an average of 6,402 coyotes from 2011 through 2016, which would represent 32.9% of the statewide coyote population estimated at 70,000 coyotes. Of the known human-induced mortality factors associated with coyotes in the State, the average annual harvest of coyotes by hunters and trappers issued a furbearer license from 2011 through 2016 accounted for over 72% of the known mortality. The cumulative known removal of coyotes within the State has ranged from 24.8% to 40.4% of the estimated statewide population.

In addition, some lethal removal of coyotes likely occurs by people issued other types of hunting/trapping licenses and by landowners and other entities to alleviate damage. The SDGFP does not conduct a survey that estimates the number of coyotes harvested by people issued other types of hunting/trapping licenses in the State and the SDGFP does not require those people to report the number of coyotes they harvest annually. However, it is likely that most of the harvest of coyotes occurs by people issued a furbearer license, which may be the reason the SDGFP does not conduct a survey to determine coyote harvest by people issued other types of hunting/trapping licenses. When landowners and other entities conduct damage management activities associated with coyotes, they are not required to report their lethal removal of coyotes to the SDGFP, WS, or other entities and the SDGFP does not conduct surveys to determine the number of coyotes lethally removed by landowners and other entities to alleviate damage. Therefore, the number of coyotes in the State lethally removed by people issued other types of hunting/trapping licenses and the number of coyotes lethally removed by landowners and other entities to alleviate damage is currently unknown.

The unique resilience of the coyote, their ability to adapt, and their 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*b*, 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.

Besides mortality that occurs to alleviate coyote damage and the coyote mortality that occurs during the annual hunting and trapping seasons, other factors would be occurring that could play a role in the dynamics of coyote populations within the State, such as diseases, food availability, and habitat changes. Voigt and Berg (1987) and Bekoff and Gese (2003) provide summaries of the diseases and parasites associated with coyotes. From 1975 through 1981, Pence et al. (1983) found that a widespread outbreak of sarcoptic mange in coyotes did not affect the population dynamics or the abundance of coyotes in south Texas. Pence et al. (1983) stated, "*Although higher mortality was associated with mange-infected* [coyotes], *this had no effect on overall mortality in the coyote population*." Further, Pence et al. (1983) stated, "…*mortality associated with mange was compensatory with other mortality factors operating within this coyote population such that overall mortality was not increased*."

In addition, food availability may influence the population dynamics of coyotes (*e.g.*, see Voigt and Berg 1987, Knowlton et al. 1999, Bekoff and Gese 2003). When discussing causes of coyote mortality, Bekoff and Gese (2003) stated, "…*starvation during crashes of food resources also may be substantial mortality factors*", especially with juvenile coyotes (Knowlton et al. 1999). As discussed previously, coyotes occur in a wide-range of available habitats across their range, including habitats altered by human activities, such as agricultural and urban areas. Therefore, changes in habitat or habitat availability are not likely to influence coyote populations directly. However, changes in habitat or habitat availability that influence the availability of food resources would likely indirectly affect the coyote population because, as noted previously, the availability of food resources can influence coyote densities in an area. Voigt and Berg (1987) stated, "*Almost any habitat, including urban areas, that supports prey populations also supports coyotes*…".

An additional concern identified is the potential cumulative effects of damage management activities on the coyote population when considering past, present, and future effects from other human 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 those types of 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. However, if WS implements Alternative 1, those activities would be occurring simultaneously with those activities that WS could conduct.

The degree to which additional factors, such as diseases, food availability, habitat changes, and other human activities, influence the population dynamics of coyotes in South Dakota is currently unknown. Although the influence those factors have on the coyote population in South Dakota are unknown, the primary cause of mortality within the general coyote population is likely direct human-induced mortality (*e.g.*, see Voigt and Berg 1987, Bekoff and Gese 2003). In studies reviewed by Voigt and Berg (1987), at least 90% of all deaths in coyotes older than five months resulted from direct human-caused mortality and in one study, trapping, snaring, and removal using a firearm represented 75% of the human-induced mortality of coyotes. When discussing the coyote in South Dakota, Miller (1995*a*) stated, "*Disease, such as distemper, hepatitis and mange (parasitic mites) provide a limited amount of natural control of the coyote populations*". Therefore, additional factors that could influence the population dynamics of coyotes in South Dakota likely have minor effects on the overall coyote population within the State.

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. In addition, immigration could result in rapid occupancy of vacant territories, which helps to explain why coyotes have thrived in spite of intensive damage management activities (Connolly 1978, Windberg and Knowlton 1988).

Historically, the cumulative known lethal removal of coyotes has not reached a magnitude that would cause the coyote population to decline in the State. From 2011 through 2016, the highest known mortality of coyotes in the State from activities conducted by the SDGFP to alleviate damage (including WS' activities) and the annual harvest of coyotes by hunters and trappers represented 40.4% of the estimated statewide population. On average, the annual removal of coyotes by the SDGFP to alleviate damage and by hunters and trappers has represented 32.9% of the estimated statewide coyote population. The annual removal of 32.9% of the statewide coyote population would be below the 60% removal level required to cause population declines calculated by Pitt et al. (2001, 2003). The cumulative mortality of coyotes would have to reach 42,000 coyotes to represent 60% of a statewide population estimated at 70,000 coyotes. From 2011 through 2016, the average annual cumulative removal of coyotes from known sources was 23,041 coyotes and ranged from 17,353 coyotes to 28,303 coyotes. Therefore, using the annual average removal of 23,041 coyotes by hunters, trappers, and the SDGFP, other mortality factors would have to represent over 45% of the annual known mortality to reach 42,000 coyotes, which is unlikely because direct human-induced mortality accounts for most of the annual mortality within a coyote population. Although some direct human-induced mortality is unknown, the additional mortality is likely low compared to known direct human-induced mortality.

Even though the magnitude that other factors have on the mortality of coyotes in the State is unknown, the coyote population does not appear to be declining statewide, which indicates the cumulative mortality effects are not reaching a magnitude that would cause a decline. 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). Therefore, if WS implements Alternative 1, available information indicates the cumulative annual mortality of coyotes from all sources would not reach an intensity level or magnitude that would cause long-term suppression or eradication of coyotes within the State.

As part of the SOPs associated with implementing Alternative 1 (see Section 2.3), WS would monitor activities to determine if the need for action and the associated impacts remain within the parameters established and analyzed in this EA. Pursuant to SOPs discussed in Section 2.3.1 and Section 2.3.2, if WS implemented Alternative 1, WS would continue to coordinate activities with the SDGFP. In addition, the activities that WS could conduct would only occur after the SDGFP and/or a tribal entity determines WS' assistance was required. The mission of the SDGFP is to provide "…*sustainable outdoor recreational opportunities through responsible management of our state's parks, fisheries and wildlife by fostering partnerships, cultivating stewardship and safely connecting people with the outdoors*" (SDGFP 2017*a*). Coordinating activities between WS and the SDGFP and WS only conducting activities when the SDGFP requests WS' assistance would ensure the SDGFP had the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the State. Similarly, coordinating activities between WS and a tribal entity and WS only conducting activities when a tribal entity seeks such assistance would ensure the tribal entity had the opportunity to incorporate any activities WS' conducts on tribal lands into population objectives established by the tribe for wildlife populations. As part of those coordinated activities, WS would submit annual activity reports to the SDGFP to aid with the ongoing monitoring efforts of the SDGFP.

By monitoring activities and implementing SOPs, WS would be able to identify and respond to changes in the coyote population that could result from natural processes and human generated changes, including those changes occurring from sources other than WS. If WS determines that a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts warrant a new or additional analysis, WS would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS can evaluate and adjust activities as changes to populations occur over time. Collins and Kays (2011) stated, "…*careful monitoring and sustainable harvest policies can be effective at preventing population declines*…".

Indirect effects associated with removing coyotes in South Dakota from implementing Alternative 1

As discussed previously, impacts that occur later in time or further removed in distance would be indirect effects. If WS implements Alternative 1, WS could lethally remove coyotes to alleviate predation risks to livestock as an integrated part of the program administered by the SDGFP to alleviate wildlife damage in the State. The removal of apex predators, such as coyotes, could indirectly cause trophic cascades to occur, including a phenomenon known as mesopredator release, which could affect biodiversity and ecosystem resilience. The potential for those indirect effects to occur from the implementation of Alternative 1 occurs below.

- *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 some 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, which 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, or large cats. Many apex predator species have experienced dramatic range contractions. Their extirpation from an area may 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 likely to control mesopredators in the presence of apex predators and limit their effects on ecosystems.

For example, the presence of coyotes may limit the density of smaller predators that 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 fox, could increase numerically when coyote populations are reduced (Robinson 1961, Nunley 1977, Crooks and Soule 1999). Berger and Conner (2008) found the recovery of wolves and an associated long-term decline in coyotes resulted in an increased survivorship among pronghorn fawns.

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, but 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 western Colorado, 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 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). In two studies conducted in south Texas, Beasom (1974) and Guthery and Beasom (1977) conducted intensive short-term predator removal 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 South Dakota 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) because rabbit and rodent populations increase at a faster rate than predator populations, factors other than predation must initiate the decline in populations. 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).

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 affect 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) because 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 South Dakota 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 may occur 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 may have resulted in decreased cottonwood regeneration in the riparian area, increases in bank erosion, and a reduction in both terrestrial and aquatic species abundance.

The topic of trophic cascades and the roles that top predators have with shaping entire ecosystems through a top-down process continues to be an important but an unsettled area of biodiversity research (*e.g.*, see Allen et al. 2017, Engeman et al. 2017, Lane 2017*a*, Lane 2017*b*). Engeman et al. (2017) stated, "*Because food webs are so complex and dynamic, even examples receiving intensive study over many years present challenges for interpretation*…" and cites research conducted by Orians et al. (1997) and Smith et al. (2016). Engeman et al. (2017) further stated, "*When the studies used to assess trophic relationships are flawed in design or have weak inferential ability, the interpretations about predators' roles within the system and the effects human management actions might have on them is perilous at best, and rightly contested*." Lane (2017*a*) stated, "*Trophic cascades…are only one type of pathway in a complicated food web*." When reviewing literature on trophic cascades to inform decisions on wildlife management, Allen et al. (2017) recommended that managers and policy makers use caution because evidence of trophic cascades "…*is not as strong as is often claimed*".

If the WS program in South Dakota continued to implement this alternative, WS' activities would not result in an elimination of coyotes. Lethal removal, when necessary, is highly specific to individual damage situations. Studies show that coyotes are highly prolific and capable of rapid repopulation from areas following localized damage management and from sport harvest (*i.e.*, hunting and trapping harvest) (Gese 1998, Blejwas et al. 2002, Williams et al. 2003). Population modeling conducted by Pitt et al. (2001, 2003) suggested that a viable coyote population could withstand an annual removal of 60% of their population without causing a decline in the population.

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). There is no evidence that the cumulative removal of coyotes that could occur in South Dakota would lead to adverse effects on ecosystems from indirect increases in mesopredators, such as raccoons, striped skunks (*Mephitis mephitis*), or red fox.

The continued implementation of this alternative would not result in the extirpation or suppression of any native predator population. The number of coyotes 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 SDGFP is responsible for managing wildlife populations in the State and implements its own program to manage damage caused by wildlife. The SDGFP has determined there was a need to request assistance from WS and for WS to integrate the capabilities of WS' aerial operations into their program to manage wildlife damage. Therefore, the continued implementation of Alternative 1 would only occur at the request of the SDGFP. Based on this information, the WS program in South Dakota concludes that potential impacts associated with the continued 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.

➢ *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, Miller et al. 2001, Estes et al. 2011). 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 Soule 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 could reduce biodiversity and shorten food web lengths. The loss of apex predators may alter the presence and abundance of mesopredators, may increase the intensity of herbivory, and ultimately may 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, Wallach et al. 2015). The presence of native predators in a healthy ecosystem may also improve the ability of the system to resist adverse effects 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

(*Lynx rufus*), 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 South Dakota implemented Alternative 1. 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 continued to implement Alternative 1. 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 could occur if WS implemented this alternative had returned to pre-removal levels within eight 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. 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.

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 target individual coyotes or groups of coyotes identified as causing damage or posing a threat of damage. Any reduction of a local coyote population is frequently temporary because immigration from adjacent areas or reproduction replaces the animals removed. WS would only provide assistance 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 South Dakota. Further, WS would only target those coyotes identified as causing damage or posing a threat. WS would not attempt to suppress coyote 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 the coyote population but to manage damage or threats associated with specific coyotes. Therefore, 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.

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 coyotes that WS could remove annually from a given landscape, no loss in ecosystem services would be attributable to WS. Because the number of coyotes that WS could remove annually would be a relatively small percentage of the overall coyote population, effects to ecosystem resilience are not likely to occur from the activities WS could conduct.

Cumulatively, the removal of coyotes is not likely to reach a threshold that would cause the population to decline. As discussed earlier, people in the State harvested an average of 16,639 coyotes and the SDGFP lethally removed an average of 6,402 coyotes (including coyotes removed by WS) from 2011 through 2016, which would represent 32.9% of the statewide coyote population in the State estimated at 70,000 coyotes. The annual removal of 32.9% of the statewide coyote population from hunting, trapping, and damage management activities would be below the 60% removal level required to cause population declines calculated by Pitt et al. (2001, 2003). In the Pitt et al. (2001, 2003) model, all populations recovered within one year when <60% of the population was removed.

As discussed previously, the SDGFP is responsible for managing wildlife populations in the State and implements its own program to manage damage caused by wildlife. The SDGFP has determined there was a need to request assistance from WS and for WS to integrate the capabilities of WS' aerial operations into their program to manage wildlife damage. Therefore, the continued implementation of Alternative 1 would only occur at the request of the SDGFP. Based on this information, the WS program in South Dakota concludes that potential impacts associated with the continued 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.

RED FOX POPULATION DIRECT, INDIRECT, AND CUMULATIVE 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 habitats 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, which is commonly an enlarged woodchuck (*Marmota monax*) or badger den. Maternity dens generally occur 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. For South Dakota, Thomas (1997) reported an average litter size of three to five pups that are born between March and May. 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, Thomas 1997).

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 may occur (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. Thomas (1997) indicated home ranges of red fox around den sites are normally between four and eight square kilometers (between 2.5 and 5 mi^2).

Red fox occur statewide in South Dakota and occur in a variety of habitats. The highest densities likely occur in the eastern third of the State and in the northwestern corner with the lowest densities occurring in the central and south-central region of the State (Thomas 1997). The actual statewide population is currently unknown. In addition, density data for red fox in South Dakota is not currently available. As discussed previously, the land area of South Dakota is approximately 75,811 square miles. If red fox occupied all the land area in the State and the density of red fox in the State was 2.6 red fox per square mile, the statewide population would be approximately 197,100 red fox. If the statewide densities were one red fox per square mile in the State, the statewide population would be approximately 76,000 red fox.

Direct effects on the red fox population in South Dakota associated with implementing Alternative 1

As discussed in Section 2.2.1, the SDGFP has requested that WS integrate aerial operations into their program to manage damage caused by wildlife in the State. If WS implements Alternative 1, WS would continue to conduct aerial operations when requested by personnel with the SDGFP and/or a tribal entity, which could include the lethal removal of red fox using a shotgun from an aircraft to alleviate livestock predation. Table 3.3 shows the number of red fox the SDGFP lethally removed by year from 2011 through 2016 to alleviate damage, which includes the red fox lethally removed by WS during aerial operations.

The SDGFP lethally removed an average of 166 red fox per year from 2011 through 2016, which includes those red fox lethally removed by WS' personnel using a shotgun from an aircraft. The highest annual removal of red fox by the program administered by the SDGFP to alleviate wildlife damage (including removal by WS) occurred in 2015 when the SDGFP lethally removed 349 red fox in the State. From 2011 through 2016, the WS program lethally removed an average of 18 red fox per year in the State using a shotgun from an aircraft. WS lethally removed red fox from an aircraft only when personnel from the SDGFP requested assistance from WS and only if the property owner or manager allowed WS to conduct aerial activities on their property. From 2011 through 2016, WS' annual removal of red fox has ranged from five to 43 red fox lethally removed. Of the 166 red fox lethally removed per year from 2011 through 2016 by the damage program administered by the SDGFP (see Table 3.3), 10.8% (18 red fox) of the total removal occurred by WS during aerial operations. Of the total number of red fox lethally removed by the wildlife damage program administered by the SDGFP, WS' removal during aerial operations has ranged from 1.4% to 49.4% of the total number of red fox lethally removed.

As shown in Table 3.3, from 2011 through 2016, the direct effects on the statewide red fox population associated with the program implemented by the SDGFP in the State to alleviate wildlife damage has ranged from 0.1% to 0.5% annually if the statewide red fox population was 76,000 red fox. The average annual removal of 166 red fox by the SDGFP from 2011 through 2016 represented 0.2% of a statewide red fox population estimated at 76,000 red fox. Based on the limited removal that occurs by the SDGFP to alleviate damage associated with red fox when compared to the estimated statewide red fox population, the activities of the SDGFP (including activities that WS could conduct) would not limit the ability of people to harvest red fox in the State.

Table 3.3 – Lethal removal of red fox in South Dakota by the SDGFP, 2011 - 2016

Year	Wildlife Damage Program Removal†	Estimated Statewide Red Fox Population	Wildlife Damage Program % of Population
2011	87	76,000	0.1%
2012	83	76,000	0.1%
2013	139	76,000	0.2%
2014	264	76,000	0.4%
2015	349	76,000	0.5%
2016	72	76,000	0.1%
Annual Average*	**166**	**76,000**	**0.2%**

†Includes those red fox lethally removed by the SDGFP to alleviate damage and those red fox removed during aerial operations by WS

*Annual average from 2011 through 2016

Overall, the activities of the SDGFP to alleviate red fox damage in the State and the use of shotguns from aircraft by WS to remove red fox causing damage would not directly affect the statewide red fox population in the State based on the limited removal occurring when compared to the estimated statewide population. Although implementing Alternative 1 could result in a localized reduction in the number of red fox at those locations where activities occur to alleviate damage, the reduction would likely be short-term because compensatory reproduction would contribute to population recovery after removals.

Similar to the direct effects on the coyote population from the implementation of Alternative 1, conducting aerial operations as an integrated part of the program administered by the SDGFP to alleviate wildlife damage in the State would be occurring simultaneously, over time, with other natural process and human generated changes that influence wildlife populations. Those process and changes would be part of the cumulative effects occurring to the red fox population in South Dakota. The cumulative effects on the red fox population in South Dakota that would be occurring simultaneously during the implementation of Alternative 1 occur below.

Cumulative effects on the red fox population in South Dakota associated with implementing Alternative 1

As discussed previously for coyotes, many natural process and human generated changes would be occurring simultaneously during the implementation of Alternative 1 that could cumulatively affect the red fox population in South Dakota. Those natural process and human generated changes would be identical to those occurring to the coyote population discussed above. In accordance with South Dakota Codified Law 41-1-1(11), the SDGFP classifies red fox as "*fur-bearing animals*" within the State that people can harvest during hunting and trapping seasons. Pursuant to South Dakota Codified Law 41-8-20 and South Dakota Administrative Rule 41:08:01:08.02, people can harvest red fox throughout the year (*i.e.*, no closed season) using legal firearms and traps with no limit on the number of red fox that people can harvest.

Table 3.4 shows the estimated number of red fox that hunters and trappers issued furbearer licenses[8] in the State harvested from 2011 through 2016. From 2011 through 2016, people issued furbearer licenses harvested an average of 1,475 red fox during the trapping season. Similarly, people issued furbearer licenses harvested an average of 316 red fox during the hunting season in the State from 2011 through 2016. From 2011 through 2016, the highest annual harvest of red fox occurred in 2012 when the SDGFP projected that people issued furbearer licenses harvested 2,695 red fox.

Table 3.4 – Known lethal removal of red fox in South Dakota by source, 2011 – 2016

Year	Harvest*		Wildlife Damage Program Removal†	TOTAL	Statewide Population	Cumulative Removal % of Population
	Trapping	Hunting				
2011	1,557	219	87	**1,863**	76,000	**2.5%**
2012	2,266	429	83	**2,778**	76,000	**3.7%**
2013	1,661	373	139	**2,173**	76,000	**2.9%**
2014	1,435	317	264	**2,016**	76,000	**2.7%**
2015	1,255	275	349	**1,879**	76,000	**2.5%**
2016	674	280	72	**1,026**	76,000	**1.4%**
Average**	**1,475**	**316**	**166**	**1,957**	**76,000**	**2.6%**

*Harvest estimate from people issued a furbearer license (people issued other types of licenses can also harvest red fox); therefore, the harvest data represents minimal estimates.

†Includes those red fox lethally removed by the SDGFP to alleviate damage and those red fox removed during aerial operations by WS

**Annual average from 2011 through 2016

As shown in Table 3.4, people in the State issued a furbearer license harvested an average of 1,791 red fox and the SDGFP lethally removed an average of 166 red fox from 2011 through 2016, which would represent 2.6% of the statewide red fox population in the State estimated at 76,000 red fox. Of the known

[8]Similar to the discussion for coyotes, the SDGFP can issue several different types of hunting and trapping licenses to people in the State. A furbearer license is one type of license the SDGFP can issue a person, which allows that person to harvest many furbearing species in the State.

human-induced mortality factors associated with red fox in the State, the average annual harvest of red fox by hunters and trappers issued a furbearer license from 2011 through 2016 accounted for over 92% of the known mortality. The cumulative known removal of red fox within the State has ranged from 2.5% to 3.7% of the estimated statewide population.

In addition, some lethal removal of red fox likely occurs by people issued other types of hunting/trapping licenses and by landowners and other entities to alleviate damage. The SDGFP does not conduct a survey that estimates the number of red fox harvested by people issued other types of hunting/trapping licenses in the State and the SDGFP does not require those people to report the number of red fox they harvest annually. However, like coyotes, it is likely that most of the harvest of red fox occurs by people issued a furbearer license, which may be the reason the SDGFP does not conduct a survey to determine red fox harvest by people issued other types of hunting/trapping licenses. When landowners and other entities conduct damage management activities associated with red fox, they are not required to report their lethal removal of red fox to the SDGFP, WS, or other entities and the SDGFP does not conduct surveys to determine the number of red fox lethally removed by landowners and other entities to alleviate damage. Therefore, the number of red fox in the State lethally removed by people issued other types of hunting/trapping licenses and the number of red fox lethally removed by landowners and other entities to alleviate damage is currently unknown.

Similar to the previous discussion on the potential cumulative effects on the coyote population associated with implementing Alternative 1, other factors would also be occurring that could play a role in the dynamics of red fox populations in the State, such as diseases, food availability, and habitat changes. When discussing red fox in South Dakota, Thompson (1997) stated, "*Mortality rates in South Dakota can vary greatly from year to year. Some of this variation can be attributed to the winter conditions; mortality rates being higher in years with very heavy snowfalls*". Voigt and Berg (1987) and Bekoff and Gese (2003) provide summaries of the diseases and parasites associated with red fox. Fox appear to be highly susceptible to rabies and an outbreak of rabies can cause high mortality rates within a red fox population. Voigt and Berg (1987) reported mortality could be as high as 60 to 80% from a rabies outbreak in a fox population. Coyotes, wolves, eagles, and large owls may occasionally prey on red fox; however, predation on red fox is not likely an important mortality factor (Thompson 1997).

Similar to the cumulative effects on the coyote population, the degree to which additional factors, such as diseases, food availability, and habitat changes, influence the population dynamics of red fox in South Dakota is currently unknown. Although the influence those factors have on the red fox population in South Dakota are unknown, the primary cause of mortality within the general red fox population is likely human-induced mortality (*e.g.*, see Voigt and Berg 1987, Bekoff and Gese 2003). In a southern Ontario study, Voigt and Berg (1987) reported that 60% of the red fox mortality occurred from hunting and trapping. When discussing the red fox in South Dakota, Thompson (1997) stated, "*By far, humans cause the greatest mortality of foxes by shooting, trapping, or hitting them with cars*".

Historically, the cumulative known lethal removal of red fox has not reached a magnitude that would cause the red fox population to decline in the State. From 2011 through 2016, the highest known mortality of red fox in the State from activities conducted by the SDGFP to alleviate damage (including WS' activities) and the annual harvest of red fox by hunters and trappers represented 3.7% of the estimated statewide population. On average, the annual removal of red fox by the SDGFP to alleviate damage and by hunters and trappers issued a furbearer license has represented 2.6% of the estimated statewide red fox population. Therefore, the cumulative annual removal of red fox would be of low magnitude when compared to the statewide red fox population. Even though the magnitude that other mortality factors have on the mortality of red fox in the State is unknown, the red fox population does not appear to be declining statewide, which indicates the cumulative mortality effects are not reaching a magnitude that would cause a decline. The International Union for Conservation of Nature and Natural

Resources considers the population of red fox to be stable across their entire range and considers red fox to be a species of "*least concern*" (Hoffmann and Sillero-Zubiri 2016). Therefore, if WS implements Alternative 1, available information indicates the cumulative annual mortality of red fox from all sources would not reach an intensity level or magnitude that would cause long-term suppression or eradication of red fox within the State.

If WS implements Alternative 1, WS would implement those SOPs discussed in Section 2.3. As part of those SOPs, WS would monitor activities to determine if the need for action and the associated impacts remain with the parameters established and analyzed in this EA. If WS implemented Alternative 1, WS would continue to coordinate activities with the SDGFP. In addition, the activities that WS could conduct would only occur after an employee with the SDGFP and/or a tribal entity determines WS' assistance was required. Coordinating activities between WS and the SDGFP and WS only conducting activities when the SDGFP requests WS' assistance would ensure the SDGFP had the opportunity to incorporate any activities WS' conducts into population objectives established for wildlife populations in the State. Similarly, coordinating activities between WS and a tribal entity and WS only conducting activities when a tribal entity seeks such assistance would ensure the tribal entity had the opportunity to incorporate any activities WS' conducts on tribal lands into population objectives established by the tribe for wildlife populations. As part of those coordinated activities, WS would submit annual activity reports to the SDGFP to aid with the ongoing monitoring efforts of the SDGFP.

By monitoring activities and implementing SOPs, WS would be able to identify and respond to changes in the red fox population that could result from natural processes and human generated changes, including those changes occurring from sources other than WS. If WS determines that a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts warrant a new or additional analysis, WS would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS can evaluate and adjust activities as changes to populations occur over time.

Indirect effects associated with removing red fox in South Dakota from implementing Alternative 1

If WS implements Alternative 1, the indirect effects associated with removing red fox to alleviate damage would be similar to those discussed previously for coyotes. People have harvested red fox during annual hunting and trapping seasons for many years in the State and the SDGFP has conducted activities to manage red fox damage for many years. There are currently no indications that previous harvest levels of red fox and previous removals to prevent red fox damage have caused an indirect increase in mesopredators or that prey populations have released (*i.e.*, increased). The cumulative evaluation includes the number of red fox that WS could lethally remove if WS implements Alternative 1. From 2011 through 2016, the average annual known cumulative removal of red fox by hunters, trappers, and the SDGFP (including removal by WS) has represented 2.6% of a statewide population estimated at 76,000 red fox. Therefore, based on the cumulative removal of red fox that occurred from 2011 through 2016, the annual cumulative removal of red fox would be of low magnitude when compared to the statewide red fox population.

Available information indicates the cumulative annual mortality of red fox from all sources would not reach an intensity level or magnitude that would cause long-term suppression or eradication of red fox within the State. Therefore, there is no evidence that the cumulative removal of red fox that could occur in South Dakota would lead to adverse effects on ecosystems from indirect increases in mesopredators or cause the release of prey populations.

CONCERNS THAT KILLING COYOTES AND RED FOX 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 or multiple coyotes and red fox in a specific area to alleviate livestock predation, the lethal removal of an individual or multiple coyotes and red fox 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. Magnitude is a measure of the number of animals killed in relation to their abundance. As discussed previously for each species, the cumulative effects of known activities (*e.g*., hunter harvest, trapper harvest, removal to alleviate damage) would not reach a magnitude that adverse effects would occur to the statewide coyote population or the statewide red fox population.

The WS program would conduct damage management activities associated with coyotes and red fox only at the request of personnel with the SDGFP and/or a tribal entity to reduce livestock predation that was occurring or to prevent further predation from occurring. The SDGFP is responsible for managing wildlife populations in the State, including the statewide coyote population and the statewide red fox population. One goal of the SDGFP is to "*Maintain and improve* [South Dakota's] *outdoor resources to ensure sustainability*" (SDGFP 2017*a*). In addition, the SDGFP applies "…*biological and social sciences to conserve and respectfully manage* [South Dakota's] *outdoor resources for current and future generations*" (SDGFP 2017*a*). Pursuant to SOPs discussed in Section 2.3, WS would continue to coordinate activities to reduce and/or prevent livestock losses in the State with the SDGFP. Coordinating activities would ensure the SDGFP had the opportunity to incorporate any activities WS' conducts into population objectives established for coyote and red fox populations in the State. As part of those coordinated activities, WS would submit annual activity reports to the SDGFP to aid with the ongoing monitoring efforts of the SDGFP. Collins and Kays (2011) stated, "…*careful monitoring and sustainable harvest policies can be effective at preventing population declines*…". In addition, the WS program would monitor activities to ensure the program identified and addressed any potential impacts. WS would work closely with the SDGFP to ensure damage management activities would not adversely affect coyote or red fox populations and that activities conducted by WS were considered as part of management goals established by the SDGFP.

EFFECTS ON THE PUBLIC'S AESTHETIC ENJOYMENT AND 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 and their aesthetic enjoyment of animals. Recreational activities can include consumptive activities, such as hunting and fishing and non-consumptive activities, such as wildlife viewing and wildlife photography. Another concern 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, and the mere knowledge that animals exists is a positive benefit to many people (Decker and Goff 1987). 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).

Recreational activities and enjoying wildlife is an important component of the economy in South Dakota. In 2011, the USFWS and the United States Department of Commerce (2011) found 662,000 people participated in wildlife-associated recreation in South Dakota, including people that participated in hunting, fishing, and wildlife watching. In total, people spent over $1.2 billion on wildlife recreation in South Dakota during 2011 (USFWS and the United States Department of Commerce 2011).

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).

As discussed in Section 1.4.1, the SDGFP is responsible for managing resident wildlife species in the State. The mission of the SDGFP is to provide "…*sustainable outdoor recreational opportunities through responsible management of our state's parks, fisheries and wildlife by fostering partnerships, cultivating stewardship and safely connecting people with the outdoors*" (SDGFP 2017*a*). As discussed in Section 1.4 and Section 2.2.1, the SDGFP has identified a need to integrate aerial operations into their wildlife damage management program and they have requested that WS integrate the aviation program administered by the WS into their wildlife damage management program. WS would only conduct activities after receiving a request from personnel with the SDGFP and/or a tribal entity and only on properties where the landowner or property manager signs a MOU, work plan, work initiation document, cooperative service field agreement, or a similar document allowing WS to conduct aerial operations. Therefore, aerial operations would occur on a relatively limited portion of the total area in South Dakota. On average, WS conducted aerial operations on 3.9% of the total land area of the State annually from FY 2012 through FY 2016. WS anticipates continuing to conduct aerial activities on a very small percentage of the land area of the State with activities primarily occurring over agricultural areas, such as rangeland, pastureland, and other agricultural areas.

The cumulative lethal removal of coyotes and red fox from all known sources of mortality in South Dakota would not reach a threshold that would cause a decline in the statewide populations of those species. From 2011 through 2016, the cumulative removal of coyotes and red fox from all known sources of mortality has been of low magnitude when compared to the estimated statewide populations of those species. There are no indications that coyote and red fox populations in the State are showing rapid declines. Although implementing Alternative 1 could result in a localized reduction in the number of coyotes or red fox at locations where activities occur, the reduction would likely be short-term because compensatory reproduction would contribute to population recovery after removals. The WS program in South Dakota does not engage in the suppression of native wildlife populations nor conducts activities to eradicate any native wildlife species.

Based on the available information, WS concludes the implementation of Alternative 1 would not limit recreational opportunities within the State and would not reduce the ability of people to enjoy the aesthetic value of coyotes and red fox within the State. In addition, coyotes and red fox continue to occur statewide and are common in appropriate habitat, but people may not commonly observe those species because they are secretive and primarily nocturnal. If WS implements Alternative 2 and no longer provided assistance, the SDGFP is likely to implement their own aerial operations and/or is likely to seek assistance with aerial operations from private entities (K. Fisk, SDGFP pers. comm. 2017, Fisk 2018). Consequently, the implementation of Alternative 2 would likely have similar effects to implementing Alternative 1 because the same or similar activities would occur by the SDGFP or private entities they hire to conduct the activities.

Alternative 2 – WS would no longer Incorporate Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP

If WS implements this alternative, WS would no longer incorporate its aerial operations into the program administered by the SDGFP to alleviate damage caused by wildlife in the State. If WS no longer assisted the SDGFP by integrating aerial operations into their damage management program, the SDGFP could take one or a combination of the following actions. The SDGFP could:

- No longer provide aerial operations to landowners and managers in South Dakota experiencing livestock predation associated with coyotes and/or red fox
- Implement their own internal aerial operations to alleviate livestock damage associated with coyotes and/or red fox
- Provide aerial operations to alleviate livestock predation by seeking the assistance of private entities that are capable of providing aerial operations

If the SDGFP implements one of the above actions, the potential impact on the statewide coyote and red fox population could be similar to Alternative 1, less than Alternative 1, or higher than Alternative 1 depending on the action(s) taken by the SDGFP and the intensity the SDGFP implements the action(s).

As discussed previously, the SDGFP currently allows people to harvest coyotes and red fox in the State throughout year. If WS implemented this alternative, people could continue to harvest coyotes and red fox in the State. Therefore, the mortality of coyotes and red fox associated with hunters and trappers harvesting coyotes and red fox would continue. In addition, the SDGFP would continue to implement their wildlife damage management program. Therefore, the mortality of coyotes and red fox would continue to occur from the damage management actions of the SDGFP.

COYOTE POPULATION DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS

Between 2011 and 2016, people issued furbearer licenses harvested an average of 16,639 coyotes per year in the State (see Table 3.5). If the statewide coyote population was 70,000 coyotes and the statewide population was stable, people harvest nearly 24% of the estimated coyote population annually. If WS had not integrated aerial operations into the damage management program of the SDGFP from 2011 through 2016, the harvest of coyotes by hunters and trappers and the removal of coyotes by the SDGFP to alleviate damage would have averaged 20,632 coyotes per year (see Table 3.5). The average harvest and removal of coyotes by hunters, trappers, and the SDGFP represented 29.5% of the estimated statewide coyote population and ranged from 21.3% to 37.9% of the statewide population. Therefore, in the absence of any assistance by WS under this alternative, hunters, trappers, and the SDGFP are likely to continue to remove approximately 29.5% of the statewide coyote population if the population remains relatively stable and may range from 21.3% to 37.9% of the statewide population.

As discussed previously, in the absence of assistance from WS, the SDGFP could take several actions. For example, the SDGFP could decide to quit providing aerial assistance during implementation of their damage management program. If the SDGFP did not provide aerial assistance, the effects on the coyote population would be less than would occur under Alternative 1. However, the SDGFP currently provides some funding to the WS program to conduct aerial operations in the State. Therefore, if WS implements this alternative and no longer provided assistance, the SDGFP is likely to implement aerial operations by using that funding to implement their own internal aerial operations and/or using that funding to seek assistance from private entities. If the SDGFP implements aerial operations but does not implement the program at the same intensity level as would occur under Alternative 1, then the effects on the coyote population would be lower than would occur under Alternative 1.

If the SDGFP implements aerial operations but at a lower intensity than would occur under Alternative 1 or the SDGFP did not implement aerial operations, personnel within the damage management program administered by the SDGFP could increase their use of other methods (*e.g.*, foothold traps, cable devices, and M-44 devices) to alleviate damage caused by coyotes. If personnel with the SDGFP increase their use of other methods to compensate for the loss of aerial operations, the number of coyotes they lethally remove could be similar to the number of coyotes that WS could lethally remove using an aircraft, if WS implemented Alternative 1. Therefore, those coyotes that WS could lethally remove during aerial operations, the SDGFP could lethally remove themselves by either implementing their own aerial operations and/or by increasing their use of other methods to alleviate damage caused by coyotes.

If the SDGFP implements aerial operations, the effects on the coyote population could be similar to Alternative 1 if the SDGFP implements aerial operations similar to what would occur if WS continued to implement Alternative 1. Similarly, if the SDGFP increases their use of other methods to compensate for the loss of aerial operations or increases their use of other methods to compensate for aerial operations that do not occur at a similar intensity level, the effects on the coyote population could be similar to Alternative 1. As discussed previously, the SDGFP provides some funding to WS to conduct aerial operations. The SDGFP has provided assistance in the past by implementing their own aerial operations in the State. Therefore, if WS did not provide assistance, the SDGFP could use the funding currently provided to WS to fund their own aerial operations.

Table 3.5 –Coyote harvest and SDGFP removal of coyotes, 2011 - 2016

Year	Known Lethal Removal		Cumulative Removal	Population Estimate**	% of Population^
	Coyote Harvest†*	SDGFP Removal‡			
2011	12,506	2,404	**14,910**	70,000	21.3%
2012	21,928	4,572	**26,500**	70,000	37.9%
2013	15,963	3,511	**19,474**	70,000	27.8%
2014	16,704	3,173	**19,877**	70,000	28.4%
2015	19,340	4,983	**24,323**	70,000	34.8%
2016	13,393	5,314	**18,707**	70,000	26.7%
Annual Average* **	**16,639**	**3,993**	**20,632**	**70,000**	**29.5%**

†Cumulative harvest by hunters and trappers

*Harvest estimate from people issued a furbearer license (people issued other types of licenses can also harvest coyotes); therefore, the harvest data represents minimal estimates.

‡Removal of coyotes by the SDGFP to alleviate coyote damage; does not include previous aerial activities of WS

**Based on the population estimate provided by Miller (1995*a*)

^Known lethal removal by hunters, trappers, and SDGFP (without WS' removal) as a percentage of the statewide population estimate

***Annual average from 2011 through 2016

In the absence of aerial operations assistance by WS, the SDGFP would likely continue with aerial operations to some or a large degree by contracting services of private pilots and airplanes, or by hiring one or more pilots and leasing or procuring a similar number of airplanes (K. Fisk, SDGFP, pers. comm. 2017). When the national WS program suspended all aerial operations temporarily to conduct a safety review following an aircraft accident in 2017, which included WS' aerial operations in South Dakota, the SDGFP hired a private pilot to conduct aerial operations in the State while WS was unable to provide assistance (Fisk 2018). Consequently, the WS program in South Dakota expects the potential effects on the coyote population from the implementation of Alternative 2 to be similar to those effects that could occur from the implementation of Alternative 1.

RED FOX POPULATION DIRECT, INDIRECT, AND CUMULATIVE EFFECTS ANALYSIS

Between 2011 and 2016, people issued furbearer licenses harvested an average of 1,790 red fox per year in the State (see Table 3.6). If the statewide population was 76,000 red fox and the statewide population was stable, people harvest nearly 2.4% of the estimated red fox population annually. If WS had not integrated aerial operations into the damage management program of the SDGFP from 2011 through 2016, the harvest of red fox by hunters and trappers and the removal of red fox by the SDGFP to alleviate damage would have averaged 1,938 red fox per year (see Table 3.6). The average harvest and removal of red fox by hunters, trappers, and the SDGFP represented 2.6% of the estimated statewide red fox population and ranged from 1.3% to 3.6% of the statewide population. Therefore, in the absence of any assistance by WS under this alternative, hunters, trappers, and the SDGFP are likely to continue to remove approximately 2.6% of the statewide red fox population if the population remains relatively stable and may range from 1.3% to 3.6% of the statewide population.

Similar to the discussion for coyotes, in the absence of assistance from WS, the SDGFP could take several actions. The SDGFP could no longer provide aerial assistance during implementation of their damage management program. If the SDGFP did not provide aerial assistance and did not increase their use of other methods, the effects on the red fox population would be less than would occur under Alternative 1. However, the SDGFP currently provides some funding to the WS program to conduct aerial operations in the State. Therefore, if WS implements this alternative and no longer provided assistance, the SDGFP is likely to implement aerial operations by using that funding to implement their own internal aerial operations and/or using that funding to seek assistance from private entities. If the SDGFP implements aerial operations but does not implement the program at the same intensity level as would occur under Alternative 1 and does not increase their use of other methods, then the effects on the red fox population would be lower than would occur under Alternative 1.

Table 3.6 – Red fox harvest and SDGFP removal of red fox, 2011 - 2016

Year	Known Lethal Removal		Cumulative Removal	Population Estimate	% of Population^
	Red Fox Harvest†*	SDGFP Removal‡			
2011	1,776	44	**1,820**	**76,000**	2.4%
2012	2,695	63	**2,758**	**76,000**	3.6%
2013	2,034	125	**2,159**	**76,000**	2.8%
2014	1,752	247	**1,999**	**76,000**	2.6%
2015	1,530	344	**1,874**	**76,000**	2.5%
2016	954	63	**1,017**	**76,000**	1.3%
Annual Average***	**1,790**	**148**	**1,938**	**76,000**	**2.6%**

†Cumulative harvest by hunters and trappers

*Harvest estimate from people issued a furbearer license (people issued other types of licenses can also harvest red fox); therefore, the harvest data represents minimal estimates.

‡Removal of red fox by the SDGFP to alleviate red fox damage; does not include previous aerial activities of WS

^Known lethal removal by hunters, trappers, and SDGFP (without WS' removal) as a percentage of the statewide population estimate

***Annual average from 2011 through 2016

If the SDGFP implements aerial operations but at a lower intensity than would occur under Alternative 1 or the SDGFP did not implement aerial operations, their damage management program could increase their use of other methods to alleviate damage caused by red fox, such as foothold trap, cable devices, and M-44 devices. If personnel with the SDGFP increase their use of other methods to compensate for the loss of aerial operations, the number of red fox they lethally remove could be similar to the number of red fox that WS could lethally remove using an aircraft, if WS implemented Alternative 1. Therefore, those red fox that WS could lethally remove during aerial operations, the SDGFP could lethally remove themselves by either implementing their own aerial operations and/or by increasing their use of other methods to alleviate damage caused by red fox.

If the SDGFP implements aerial operations, the effects on the red fox population could be similar to Alternative 1 if the SDGFP implements aerial operations similar to what would occur if WS continued to implement Alternative 1. As discussed previously, the SDGFP provides some funding to WS to conduct aerial operations. The SDGFP has provided assistance in the past by implementing their own aerial operations in the State. Therefore, if WS did not provide assistance, the SDGFP could use the funding currently provided to WS to fund their own aerial operations. In the absence of aerial operations assistance by WS, the SDGFP would likely continue with aerial operations to some or a large degree by contracting services of private pilots and airplanes, or by hiring one or more pilots and leasing or procuring a similar number of airplanes (K. Fisk, SDGFP, pers. comm. 2017). When the national WS program suspended all aerial operations temporarily to conduct a safety review following an aircraft accident in 2017, which included WS' aerial operations in South Dakota, the SDGFP hired a private pilot to conduct aerial operations in the State while WS was unable to provide assistance (Fisk 2018). Consequently, the WS program in South Dakota expects the potential effects on the red fox population from the implementation of Alternative 2 to be similar to those effects that could occur from the implementation of Alternative 1.

3.2.2 Issue 2 - Effects on Non-target Species Populations, Including T&E Species

As discussed previously, a concern would be the potential impacts to non-target species, including T&E species, from activities to alleviate livestock predation associated coyotes and/or red fox. 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 to Incorporate WS' Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP (No Action/Proposed Action)

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). Aerial operations could be an important method of damage management in South Dakota when used to address damage or threats in remote areas. An issue that has arisen is the potential for low-level flights to disturb wildlife, including T&E species, and the potential to misidentify a non-target animal as a coyote or red fox.

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

Between FY 2012 and FY 2016, WS' personnel did not lethally remove any non-target animals during aerial operations in South Dakota. In addition, WS did not observe, document, nor was WS made aware of any adverse effects to non-target animals from low-level overflights that occurred from aerial operations that WS conducted in South Dakota.

EFFECTS ON NON-TARGET ANIMAL POPULATIONS FROM CONTINUING ALTERNATIVE 1

Aerial operations conducted by WS generally consist of ferrying to a location and once at a location, surveying for target animals and, if target animals are located, the actual pursuit of target animals. Ferrying generally consists of the aircraft travelling from an airport to a location where the aircraft would conduct activities and then returning from a location where activities occurred to an airport. Ferrying also includes an aircraft travelling from a location where activities have finished to another location where WS would conduct activities. Ferrying generally involves the aircraft flying at a higher altitude to avoid ground obstacles. Because ferrying involves flying at higher levels above the ground, WS' aircraft would generally not disturb animals during ferry times because animals are unlikely to hear and/or see the aircraft. If animals do hear and/or see the aircraft during ferry times, the noise and the distance of the aircraft is not likely to be loud enough and/or close enough to cause any direct or indirect effect on non-target species.

When searching for a coyote and/or red fox on a property where the landowner or manager signs a document allowing such activities to occur, WS' pilots generally fly an aircraft low to the ground to allow the pilot and/or the crewmember to identify the animal. Therefore, flights would typically be of low level during surveying, pursuit, and the actual shooting of coyotes and/or red fox. WS' pilots do not intentionally pursue non-target animals when conducting aerial operations. When the pilot and/or crewmember identify a target animal, the WS' pilot brings the aircraft within shooting distance of the target animal. Therefore, searching for target animals and shooting target animals from the aircraft occur at much lower altitudes than aircraft that are ferrying from one location to another location. During aerial operations, the pilot and/or the crewmember would positively identify the target animal prior to discharging the shotgun.

Shooting from an aircraft would occur during daylight hours in areas with good visibility to identify target animals. In addition, shooting from an aircraft to address damage would often be limited to times of the year when the lack of visual obstruction, such as vegetation, was minimal. Therefore, use of firearms would essentially be selective for target animals because identification of the target would occur prior to application; however, there is a slight potential for misidentification of an animal, especially other native canid species, such as gray fox (*Urocyon cinereoargenteus*), swift fox (*Vulpes velox*), and gray wolves (*Canis lupus*). Coyotes and red fox have many characteristics that make them identifiable from other species, which reduces the risk of a pilot unintentionally pursing a non-target animal or a crewmember shooting an animal unintentionally from an aircraft.

Grey fox occur statewide in appropriate habitat and people can harvest gray fox using hunting and trapping methods throughout the year in the State with no closed season. Gray fox are generally shorter in stature than red fox because they generally have shorter legs; however, gray fox and red fox are generally similar in size because the gray fox tends to be more robust than the red fox (Fritzell 1987). Although gray fox and red fox are similar in size, as their common names suggest, the pelage color of the two species is recognizably different. Pelage coloration differences between gray fox and red fox allow people to distinguish between the two species. Therefore, it is highly unlikely a WS pilot or crewmember would misidentify a gray fox as a red fox. Pelage coloration between gray fox and coyotes are similar in appearance, which could lead to misidentification. In general, coyotes are larger than gray fox, which would allow WS' pilots and crewmembers to distinguish between the two species. Gray fox generally weigh between 3.0 to 7.0 kilograms (Cypher 2003). In comparison, male coyotes weigh from 10.3 kilograms to 16.0 kilograms and females weigh between 8.0 kilograms and 14.2 kilograms (Bekoff and Gese 2003). Because of the size difference between coyotes and gray fox, WS does not anticipate incorrectly identifying a gray fox as a coyote. Therefore, WS does not anticipate any unintentional take of gray fox to occur in the future during aerial operations conducted by WS. During the implementation of aerial operations by WS from FY 2012 through FY 2016, no intentional or unintentional removal of non-target animals occurred by WS' personnel within the State, including gray fox.

In South Dakota, the South Dakota Game, Fish and Parks Commission designated the swift fox as a state threatened species. The USFWS has designated the gray wolf to be an endangered species in the State pursuant to the ESA. Discussion related to the implementation of Alternative 1 on the swift fox and gray wolf occurs in the following subsection that analyzes the risks to threatened or endangered species.

The noise associated with the discharge of a shotgun, if occurring near a non-target animal could elicit a flight response. However, the use of a shotgun in proximity to non-target animals is not likely to occur at a high frequency or at a high magnitude. For harassment to occur from the noise associated with the discharge of a shotgun, a non-target animal or animals would have to be present within hearing distance at the time a crewmember discharged the shotgun and the resulting noise would have to elicit a negative response.

In addition to the noise associated with the discharge of a shotgun, aircraft overflights have created concerns about disturbing wildlife. Of concern are the possible negative physiological and/or behavioral effects that low-level overflights could cause, which could reduce the fitness of an animal or the ability of an animal to survive, especially if the exposure to the stressor is chronic. The National Park Service (1995) reviewed studies on the effects of aircraft overflights on wildlife. If stress occurs to animals from aircraft overflights, the negative effects associated with the overflights could be exacerbated by other deleterious stressors already occurring (*e.g.*, food shortage, diseases). The stress from harassment could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs (National Park Service 1995).

A National Park Service (1995) 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 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.

The following are examples of species or species groups that people have evaluated the issue of aircraft-generated disturbance.

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. 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.

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.

Bald eagles and golden eagles may be present in areas where WS' aerial activities occur. The Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act protect the bald eagle and the golden eagle from a variety of harmful actions and impacts. Under the Bald and Golden Eagle Protection Act (16 USC 668-668c), the take of bald eagles and golden eagles is prohibited without a permit from the USFWS. Under the Bald and Golden Eagle Protection Act, the definition of "*take*" includes actions that may "*disturb*" eagles. Disturb has been defined under 50 CFR 22.3 as those actions that cause, or are likely to cause, injury to an eagle, a decrease in productivity, or nest abandonment by substantially interfering with their normal breeding, feeding, or sheltering behavior.

The USFWS developed national bald eagle management guidelines to advise people of when and under what circumstances the protective provisions of the Bald and Golden Eagle Protection Act may apply to their activities (see USFWS 2007). A variety of human activities can potentially interfere with bald eagles and golden eagles, affecting their ability to forage, nest, roost, breed, or raise young. The USFWS developed the bald eagle management guidelines to help people minimize such impacts to eagles, particularly where they may constitute "*disturbance*".

WS would only conduct limited harassment activities near active eagle nests and Important Eagle Use Areas[9] in accordance with the National Bald Eagle Management Guidelines (USFWS 2007). The categories from the guidelines that would encompass WS' aerial activities are Category G (aircraft use). Category G activities generally call for a buffer of 1,000 feet around active nests. Although similar guidelines do not exist for golden eagles, WS would apply those guidelines when encountering golden eagles. WS does not expect aerial activities to agitate or bother a bald eagle or golden eagle to a degree that causes, or is likely to cause, a decrease in its productivity or cause nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. WS based this determination on its adherence to the national bald eagle management guidelines (see USFWS 2007) and the SOPs discussed in Section 2.3.

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 because 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

[9]Pursuant to 50 CFR 22.3, the definition of an Important Eagle-use Area is "…*an eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles*."

nests on foot. Ellis (1981) reported that five species of hawks, two falcons (*Falco* spp.), and golden eagles 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.

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 South Dakota, WS provides the information to demonstrate 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 appear to exist 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 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).

The amount of time WS' spends 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. In general, WS spends relatively little time over any one area when conducting aerial operations. Flights over a particular area are often of short duration and frequency. On average, WS spent less than 10 minutes per square mile conducting aerial operations on those properties where WS conducted aerial operations from FY 2012 through FY 2016. In addition, aerial operations do not usually occur on the same property with enough frequency to cause chronic exposure to aircraft. On average, WS conducted aerial operations on 3.9% of the total land area of the State annually from FY 2012 through FY 2016. WS anticipates continuing to conduct aerial activities on a very small percentage of the land area of the State, which would not expose most non-target animals to aerial overflights.

Further lessening the potential for any direct or indirect effects would be that such flights occur infrequently throughout the year. The use of firearms from aircraft by WS would occur in remote areas where tree cover and vegetation allows for visibility of target animals from the air. Good visibility and relatively clear and stable weather conditions are required for effective and safe aerial operations. Summer conditions can limit the effectiveness of aerial operations as heat reduces coyote and red fox activity and vegetative ground cover greatly hampers visibility. Air temperature (high temperatures), which influences air density, affects low-level flight safety and may restrict aerial operation activities. In scrublands or deciduous cover, aerial operations are more effective in winter when the leaves have fallen or in early spring before the leaves emerge, which improves visibility.

In conclusion, the use of firearms from aircraft would essentially be selective for coyotes and red fox because aircrews would identify a target animal prior to shooting. WS' pilots may encounter non-target animals while conducting aerial operations; however, pilots generally avoid non-target animals and they do not pursue non-target animals with aircraft. The use of low-flying aircraft and firearms by WS' personnel does not usually affect non-target species, except for the occasional scaring that may result from the noise associated with discharging a firearm or the low-level flight of the aircraft. In those cases, affected non-target animals may temporarily leave the immediate vicinity, but would most likely return after conclusion of the action in the absence of continued disturbance. The use of low-flying aircraft and firearms would only occur for a limited duration, which is not likely to result in complete dispersal of non-target species from an area.

The fact that WS would only conduct aerial activities on a very small percentage of the land area of the State indicates that implementation of Alternative 1 would not expose most wildlife in the State to aerial overflights. Further lessening the potential for any adverse effects is that such flights occur infrequently throughout the year. WS has used fixed-wing aircraft and helicopters for aerial shooting in areas inhabited by wildlife for many 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 in any given year. As a result, no known problems to date have occurred to wildlife from overflights associated with WS' aerial operations and WS does not anticipate any in the future. In addition, the activities that WS could conduct would not limit the ability of people to view, enjoy, and/or harvest non-target wildlife in the State. Section 2.3 discusses the SOPs that WS' pilots and crewmembers would incorporate into aerial operations to prevent and reduce any potential adverse effects on non-target animals.

ANALYSIS OF RISKS TO THREATENED AND ENDANGERED SPECIES

WS would make special efforts to avoid jeopardizing threatened or endangered species through biological evaluations of potential effects and the establishment of special restrictions or minimization measures through consultation with the USFWS. 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)].

During the development of this EA, WS reviewed the current list of species designated as threatened or endangered in South Dakota as determined by the USFWS. WS conducted a review of potential impacts of aerial operations on each of those species listed in Table 3.7. The evaluation took into consideration the direct and indirect effects of aerial operations to alleviate livestock predation associated with coyotes and red fox. WS reviewed the status, critical habitats designations, and current known locations of those species identified in Table 3.7. As part of the review process, WS prepared and submitted a biological evaluation to the USFWS as part of the consultation process pursuant to Section 7 of the ESA.

WS determined the continued implementation of Alternative 1 would have no effect on most species listed as threatened or endangered by the USFWS (see Table 3.7). For the gray wolf and black-footed ferret (*Mustela nigripes*), WS determined that continued implementation of the Alternative 1 "*may affect*" the gray wolf and black-footed ferret but those effects would be solely beneficial, insignificant, or discountable, which would warrant a "*not likely to adversely affect*" determination (see Table 3.7). The USFWS concurred with WS' effects determination (S. Larson, USFWS pers. comm. 2017).

The only species listed as threatened or endangered by the USFWS that is similar in appearance to coyotes and red fox is the gray wolf. Size and pelage coloration differences between gray wolves and red fox allow people to distinguish between the two species. Therefore, it is highly unlikely a WS pilot or crewmember would misidentify a gray wolf as a red fox. Pelage coloration between gray wolves and coyotes are similar in appearance, which could lead to misidentification. However, gray wolves are generally larger than coyotes (Bekoff and Gese 2003, Paquet and Carbyn 2003), which would allow WS pilots and crewmembers to distinguish between the two species. In general, gray wolves are two to three times larger than coyotes. Male coyotes generally weigh from 10.3 kilograms to 16.0 kilograms while females generally weigh between 8.0 kilograms and 14.2 kilograms (Bekoff and Gese 2003). In contrast, male wolves generally weigh from 20 to 80 kilograms and female wolves weigh between 16 and 55 kilograms (Paquet and Carbyn 2003).

In addition, WS would only conduct aerial operations at the request of an employee of the SDGFP and/or a tribal entity. If a wolf were active in an area, the employee of the SDGFP and/or the tribal entity would likely have identified the presence of the wolf based on evidence (*e.g.*, scat, tracks) of their presence.

Therefore, personnel of the SDGFP and/or a tribal entity could potentially identify and make WS aware of the presence of a wolf in an area, which would allow WS to avoid those areas. As discussed previously, WS prepared and submitted a biological evaluation to the USFWS that determined implementation of Alternative 1 may affect but would not adversely affect gray wolves in South Dakota and the USFWS concurred with WS' effects determination.

Table 3.7 – Federal list of threatened or endangered species in South Dakota

Common Name	Scientific Name	Status†	Determination‡
Animals			
Clams			
Higgins Eye	*Lampsilis higginsii*	E	NE
Scaleshell Mussel	*Leptodea leptodon*	E	NE
Insects			
American Burying Beetle	*Nicrophorus americanus*	E	NE
Dakota Skipper	*Hesperia dacotae*	T	NE
Poweshiek Skipperling	*Oarisma poweshiek*	E	NE
Fish			
Pallid Sturgeon	*Scaphirhynchus albus*	E	NE
Topeka Shiner	*Notropis topeka*	E	NE
Mammals			
Gray Wolf	*Canis lupis*	E	MANLAA
Black-footed Ferret	*Mustela nigripes*	E/EXP	MANLAA
Northern Long-eared Bat	*Myotis septentrionalis*	T	NE
Birds			
Piping Plover	*Charadrius melodus*	T	NE
Least Tern	*Sterna antillarum*	E	NE
Whooping Crane	*Grus americana*	E	NE
Red Knot	*Calidris canutus rufa*	T	NE
Plants			
Western Prairie Fringed Orchid	*Platanthera praeclara*	T	NE
Leedy's Roseroot	*Rhodiola integrifolia ssp. leedyi*	T	NE

†T=Threatened; E=Endangered; EXP=Experimental Population
‡NE=No effect; MANLAA=May affect, not likely to adversely affect

The USFWS has also designated critical habitat in South Dakota for some of the species listed as threatened or endangered. Table 3.8 provides a list of those species with critical habitat designated in South Dakota along with WS' effects determination. WS' based the effects determinations on a review of the proposed aerial activities. The USFWS concurred with WS' effects determination for critical habitats designated in South Dakota (S. Larson, USFWS pers. comm. 2017). WS would continue to review the species listed as threatened or endangered by the USFWS and would continue to consult with the USFWS, as appropriate.

Table 3.9 shows those species designated by the South Dakota Game, Fish and Parks Commission as threatened or endangered within the State. The WS program in South Dakota has also reviewed the list of species the South Dakota Game, Fish and Parks Commission has designated as threatened or endangered. Based on the review of species listed in the State, WS has determined that the proposed activities would have no effect on those species currently listed as threatened or endangered by the South Dakota Game, Fish and Parks Commission. WS would continue to review the species listed as threatened or endangered by the South Dakota Game, Fish and Parks Commission. As appropriate, the WS program would continue to consult with the SDGFP when WS determines activities may affect a threatened or endangered species designated by the South Dakota Game, Fish and Parks Commission.

Table 3.8 – Critical habitats designated in South Dakota

Common Name	Scientific Name	Status†	Determination‡
Insects			
Dakota Skipper	*Hesperia dacotae*	CH	NE
Poweshiek Skipperling	*Oarisma poweshiek*	CH	NE
Birds			
Piping Plover	*Charadrius melodus*	CH	NE

†CH=Critical Habitat

‡NE=No Effect

Another canid species that has a general appearance similar to coyotes and red fox is the swift fox. The South Dakota Game, Fish, and Parks Commission designated the swift fox as a state threatened species. In South Dakota, swift fox are primarily associated with heavily grazed prairie habitats in the western portion of the State where they are usually associated with prairie dog (*Cynomys ludovicianus*) or ground squirrel (*Spermophilus* spp.) colonies (SDGFP 2014). Efforts have occurred to restore swift fox populations within South Dakota (Honness et al. 2008, Dowd Stukel 2011). The size and pelage coloration differences between swift fox and red fox allow people to distinguish between the two species. Therefore, it is highly unlikely a WS pilot or crewmember would misidentify a swift fox as a red fox. Pelage coloration between swift fox and coyotes are similar in appearance, which could lead to misidentification. In general, coyotes are larger than swift fox, which would allow WS' pilots and crewmembers to distinguish between the two species. Swift fox generally weigh between 1.9 to 2.4 kilograms (Cypher 2003) while coyotes range from 10.3 kilograms to 16.0 kilograms for males and between 8.0 kilograms and 14.2 kilograms for females (Bekoff and Gese 2003). Because of the size difference between coyotes and swift fox, WS does not anticipate incorrectly identifying a swift fox as a coyote. Therefore, WS does not anticipate any unintentional take of swift fox to occur in the future during aerial operations conducted by WS.

If aerial overflights occurred in areas where swift fox were present, WS does not expect any direct or indirect effects to occur. Aerial operations conducted by WS generally consist of ferrying to a location and once at a location, the actually pursuit of target animals. Ferrying generally involves the aircraft flying at a higher altitude to avoid ground obstacles. Because ferrying involves flying at higher levels above the ground, WS' aircraft would generally not disturb swift fox during ferry times because swift fox are unlikely to hear and/or see the aircraft. If a swift fox does hear and/or see the aircraft during ferry times, the noise and the distance of the aircraft is not likely to be loud enough and/or close enough to cause any direct or indirect effect.

Although aircraft fly low to the ground while surveying, identifying, and shooting at a target animal, the aircraft would not be low enough to the ground to strike a swift fox if activities were occurring in areas occupied by swift fox. Although swift fox can be active during the day, they are primarily nocturnal and spend much of the daytime underground in burrows. The presence of low-flying aircraft could disturb a swift fox if the swift fox were above ground and in the immediate vicinity of the aircraft during attempts to locate, identify, or shoot at target animals. The disturbance could cause a swift fox to enter a nearby burrow; however, WS does not expect any direct or indirect effect to occur in the absence of persistent disturbance. In addition, aerial operations do not occur at night when swift fox are much more active. Because swift fox are not as active during the daytime, it is unlikely that WS would encounter a swift fox during aerial operations.

Table 3.9 – State list of threatened or endangered species in South Dakota

Common Name	Scientific Name	Status[†]
Fish		
Banded Killifish	*Fundulus diaphanous*	SE
Blacknose Shiner	*Notropis heterolepis*	SE
Finescale Dace	*Chrosomus neogaeus*	SE
Longnose Sucker	*Catostomus catostomus*	ST
Northern Pearl Dace	*Margariscus nachtriebi*	ST
Northern Redbelly Dace	*Chrosomus eas*	ST
Pallid Sturgeon	*Scaphirhynchus albus*	SE
Sicklefin Chub	*Macrhybopsis meeki*	SE
Sturgeon Chub	*Macrhybopsis gelida*	ST
Reptiles and Amphibians		
Eastern Hognose Snake	*Heterodon platirhinos*	ST
False Map Turtle	*Graptemys pseudogeographica*	ST
Lined Snake	*Tropidoclonion lineatum*	SE
Mammals		
Black-footed Ferret	*Mustela nigripes*	SE
River Otter	*Lontra canadensis*	ST
Swift Fox	*Vulpes velox*	ST
Birds		
American Dipper	*Cinclus mexicanus*	ST
Eskimo Curlew	*Numenius borealis*	SE
Least Tern	*Sterna antillarum*	SE
Osprey	*Pandion haliaetus*	ST
Peregrine Falcon	*Falco peregrinus*	SE
Piping Plover	*Charadrius melodus*	ST
Whooping Crane	*Grus americana*	SE

[†]ST=State Threatened; SE=State Endangered

Although predation is a natural event, when populations of certain species are low due to other factors, predation can be a limiting factor in recovery. Within swift fox populations, predation by coyotes is often the primary source of mortality (Honness et al. 2008, Dowd Stukel 2011). During efforts to restore swift fox to portions of western South Dakota, one objective of those release efforts was to reduce the abundance of coyotes temporarily within the swift fox release area, which included using private fixed-winged aircraft to shoot coyotes (Honness et al. 2008). If WS implements Alternative 1, WS would only conduct aerial operations to alleviate livestock predation associated with coyotes and/or red fox. Therefore, WS would not conduct activities to remove coyotes and/or red fox to alleviate specific predation risks to swift fox. However, removing coyotes and/or red fox in areas where swift fox occur could potentially have an indirect benefit by reducing predation risks if the home range of those coyotes overlapped areas where swift fox occurred.

During the implementation of aerial operations by WS from FY 2012 through FY 2016, no intentional or unintentional removal of non-target animals occurred by WS' personnel within the State, including gray wolves and swift fox.

Alternative 2 – WS would no longer Incorporate Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP

If WS implements this alternative approach, WS would initiate processes to terminate any existing agreements with the SDGFP relating to the integration of WS' aircraft and associated personnel into the program administered by the SDGFP to manage wildlife damage in the State. At the end of the termination process, the WS program would no longer conduct any aerial operations to alleviate livestock predation associated with coyotes and/or red fox in South Dakota. Therefore, no direct impacts to non-targets or threatened or endangered species would occur by WS if WS implemented this alternative.

As discussed in Section 3.2.1, if the WS program no longer conducted aerial operations to alleviate livestock predation associated with coyotes and/or red fox, the SDGFP could take one or a combination of the following actions. The SDGFP could:

- No longer provide aerial operations to landowners and managers in South Dakota experiencing livestock predation associated with coyotes and/or red fox
- Implement its own internal aerial operations to alleviate livestock damage associated with coyotes and/or red fox
- Provide aerial operations to alleviate livestock predation by seeking the assistance of private entities that are capable of providing aerial operations

If the SDGFP implements one of the above actions, the potential impacts on the population of non-target species could be similar to Alternative 1, less than Alternative 1, or higher than Alternative 1 depending on the action(s) taken by the SDGFP and the intensity the SDGFP implements the action(s).

If the SDGFP does not provide aerial assistance or provides aerial assistance but at a lower intensity level than would occur under Alternative 1, the SDGFP and/or other entities could increase their usage and intensity levels of other methods, such as foothold traps or the use of the M-44 device containing sodium cyanide. Those methods may be less selective than using a shotgun from an aircraft when targeting coyotes and/or red fox. Shooting from an aircraft may reduce the need to use other methods, such as foothold traps, cable devices, and M-44 devices, and reduce the number of hours spent using other methods, which could reduce the risk of capturing or killing a non-target animal with those methods (*e.g.*, see Wagner and Conover 1999). When using an aircraft, the pilot and/or the crewmember would positively identify a coyote and/or red fox before firing a shotgun; therefore, shooting would essentially be selective for a target species. An increase in the use of less selective methods could lead to people lethally removing a higher number of non-target animals. In addition, risks to non-target animals 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. However, it would be difficult to determine how much of an increase would occur.

The SDGFP has provided assistance in the past by implementing their own aerial operations in the State. Therefore, if WS did not provide assistance, the SDGFP could use the funding currently provided to WS to fund their own aerial operations. In the absence of aerial operations assistance by WS, the SDGFP would likely continue with aerial operations to some or a large degree by contracting services of private pilots and airplanes, or by hiring one or more pilots and leasing or procuring a similar number of airplanes (K. Fisk, SDGFP, pers. comm. 2017). When the national WS program suspended all aerial operations temporarily to conduct a safety review following an aircraft accident in 2017, which included WS' aerial operations in South Dakota, the SDGFP hired a private pilot to conduct aerial operations in the State while WS was unable to provide assistance (Fisk 2018). Consequently, the WS program in South Dakota expects the potential effects on the populations of non-target animals from the implementation of Alternative 2 to be similar to those effects that could occur from the implementation of Alternative 1.

3.2.3 Issue 3 - Effects of Damage Management Methods on Human Safety

A common concern is the potential adverse effects that methods available could have on human health and safety. This section analyzes the threats to human safety that could occur from WS' implementation of Alternative 1 or Alternative 2.

Alternative 1 - Continue to Incorporate WS' Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP (No Action/Proposed Action)

If the WS program in South Dakota implements Alternative 1, WS would use a shotgun from an aircraft to target coyotes and/or red fox predating on livestock or posing a threat of predation. Human safety concerns would involve the use of a shotgun from an aircraft and the threat to human safety associated with aircraft accidents.

HUMAN SAFETY CONCERNS ASSOCIATED WITH THE USE OF A FIREARM

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)). The security of firearms would also occur pursuant to WS Directive 2.615.

Crewmembers who use firearms from within an aircraft would receive safety training, including the safe use of a firearm within an aircraft, pursuant to the WS Aviation Operations and Safety Manual. Crewmembers who use firearms from within an aircraft must meet and maintain minimum certification and qualification requirements established by the WS Aviation Training and Operations Center.

HUMAN SAFETY CONSEQUENCES OF AERIAL WILDLIFE OPERATIONS ACCIDENTS

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 when comparing the safety margins associated with high-level flights. In 1998, the WS program commissioned an independent review of its aerial shooting 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 establish an Aviation Training and Operations Center to support aerial activities and WS 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 would be highly skilled with commercial pilot ratings that have passed proficiency tests in the flight environment encountered by the WS program. 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 associated with aerial operations would follow the policies and directives set forth in WS Directive 2.620, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137. 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.

The WS program aircraft-use policy helps ensure the program conducts aerial shooting in a safe and environmentally sound manner, in accordance with federal and state laws. The WS program must certify pilots and aircraft under established WS program procedures and only crewmembers that have received training through the WS Aviation Training and Operations Center can use firearms from aircraft. For safety reasons, the pilot would be in contact with a ground crew while conducting aerial operations. Ground crews would consist of personnel from the SDGFP. If aerial activities were occurring on properties owned and/or managed by a tribal entity, ground crews could consist of personnel from the SDGFP, personnel from WS, and/or personnel from tribal entities. Ground crews would receive appropriate WS' training to monitor aerial activities and, if necessary, initiate emergency procedures if an accident occurred.

EXECUTIVE ORDERS RELATING TO CHILDREN AND ENVIRONMENTAL JUSTICE

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. Activities conducted pursuant to Alternative 1 would occur by using only legally available and approved methods where it is highly unlikely that activities conducted pursuant to Alternative 1 would adversely affect children. For these reasons, WS concludes that it would not create an environmental health or safety risk to children from implementing Alternative 1. In addition, WS does not anticipate the implementation of Alternative 1 would result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations.

CONCLUSIONS RELATED TO HUMAN SAFETY CONCERNS

No adverse effects to human safety have occurred from WS' implementation of Alternative 1 in the State from FY 2012 through FY 2016. WS considers the risks to human safety from the use of shotguns from aircraft, when used appropriately and by trained personnel, to be low. Based on the use patterns of methods available to address damage caused by coyotes and red fox, Alternative 1 would comply with Executive Order 12898 and Executive Order 13045.

Alternative 2 – WS would no longer Incorporate Aerial Operations into the Wildlife Damage Management Program Administered by the SDGFP

As discussed previously, if the WS program no longer conducted aerial operations to alleviate livestock predation associated with coyotes and/or red fox, the SDGFP could take one or a combination of several actions. If the SDGFP implements one or a combination of those actions, the potential impacts on human safety could be similar to Alternative 1, less that Alternative 1, or higher than Alternative 1 depending on the action(s) taken by the SDGFP and the intensity the SDGFP implements the action(s).

The SDGFP currently provides some funding to the WS program to conduct aerial operations in the State. In addition, the SDGFP has provided assistance in the past by implementing their own aerial operations in the State. Therefore, if WS implements this alternative and no longer provided assistance, the SDGFP is likely to implement aerial operations by using that funding to implement their own internal aerial operations and/or using that funding to seek assistance from private entities (K. Fisk, SDGFP, pers.

comm. 2017, Fisk 2018). If the SDGFP implements aerial operations, the risks to human safety could be similar to Alternative 1 if the SDGFP implements aerial operations similar to what would occur if WS continued to implement Alternative 1. If the SDGFP implements aerial operations but does not implement the program at the same intensity level as would occur under Alternative 1, then the risks to human safety would be lower than would occur under Alternative 1. If the SDGFP did not provide aerial assistance, the risks to human safety would be less than would occur under Alternative 1.

If the SDGFP does not provide aerial assistance or provides aerial assistance but at a lower intensity level than would occur under Alternative 1, the SDGFP and/or other entities could increase their usage and intensity levels of other methods, such as foothold traps or the use of the M-44 device containing sodium cyanide. For example, Wagner and Conover (1999) predicted that effective preventive aerial operations that removed coyotes three to six months prior to ewes having lambs could lead to a corresponding decrease in the need to remove coyotes using traps, cable devices, and M-44 devices during the lambing season. The use of other methods could result in human safety risks similar to or higher than could occur if WS continued to implement Alternative 1.

3.3 SUMMARY AND CONCLUSION

Based on the best available information, the analyses in Section 3.2.1 indicate the direct and cumulative effects on the statewide coyote and red fox population associated with implementing Alternative 1 would be of low magnitude. The cumulative lethal removal of coyotes and red fox from all known sources of mortality in South Dakota would not reach a threshold that would cause a decline in the statewide populations of those species. There are no indications that coyote and red fox populations in the State are showing rapid declines. People can harvest coyotes and red fox in the State at any time with no limit on the number of coyotes and red fox that people can harvest, which indicates those species are not at risk of overharvesting. Although implementing Alternative 1 could result in a localized reduction in the number of coyotes or red fox at locations where activities occur, the reduction would likely be short-term because compensatory reproduction would contribute to population recovery after removals. If WS implements Alternative 2 and no longer provided assistance, the SDGFP is likely to implement their own aerial operations and/or is likely to seek assistance with aerial operations from private entities (K. Fisk, SDGFP pers. comm. 2017, Fisk 2018). Consequently, the implementation of Alternative 2 would likely have similar effects to implementing Alternative 1 because the same or similar activities would occur by the SDGFP or private entities they hire to conduct the activities.

Available information indicates the cumulative annual mortality of coyotes and red fox from all sources would not reach an intensity level or magnitude that would cause long-term suppression or eradication of those species within the State. The potential impacts associated with the continued implementation of Alternative 1 would not be of sufficient magnitude or scope at the local or state level to cause trophic cascades or impact biodiversity. 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. The available information indicates that the cumulative removal of coyotes or red fox that has occurred or that could occur in South Dakota would not lead to adverse effects on ecosystems from indirect increases in mesopredators (*e.g.,* striped skunks, raccoons). Similarly, available information indicates the cumulative annual mortality of coyotes and red fox would not lead to adverse effects on biodiversity within the State. As discussed previously, the implementation of Alternative 2 would likely have similar effects to implementing Alternative 1 because the same or similar activities would occur by the SDGFP or private entities they hire to conduct the activities.

If WS implemented Alternative 1, the use of firearms from an aircraft would essentially be selective for target animals because identification of the target would occur prior to pursuing a target animal.

However, there is a slight potential for misidentification of an animal, especially other native canid species. Coyotes and red fox have many characteristics that make them identifiable from other species, which would reduce the risk of a pilot unintentionally pursing a non-target animal or a crewmember shooting an animal unintentionally from an aircraft. From FY 2012 through FY 2016, WS' personnel did not lethally remove any non-target animals during aerial operations in South Dakota. There is also a concern about the potential for low-level flights to disturb wildlife. In general, the potential for adverse effects appear to occur when overflights are frequent, such as hourly, and over long periods of time, which represents chronic exposure. WS would conduct aerial activities on a very small percentage of the land area within the State; therefore, implementation of Alternative 1 would not expose most wildlife in the State to aerial overflights and would occur infrequently throughout the year. In addition, low-level overflights generally occur for less than 10 minutes per square mile. WS has used fixed-wing aircraft and helicopters for aerial shooting in areas inhabited by wildlife for many years. No known problems to date have occurred to wildlife from overflights associated with WS' aerial operations and WS does not anticipate any in the future from implementation of Alternative 1. If WS implements Alternative 2, the SDGFP would likely implement their own aerial activities or hire private entities to conduct aerial activities in the State, which would likely have similar effects to implementing Alternative 1.

The risks to human safety from the use of shotguns from aircraft, when used appropriately and by trained personnel, would be low. The WS program must certify pilots and aircraft under established WS program procedures and only crewmembers that have received training through WS' Aviation Training and Operations Center can use firearms from aircraft. Pilots would be highly skilled and would have to pass proficiency tests in the flight environment encountered by the WS program. All WS' personnel associated with aerial operations would follow the policies and directives set forth in WS Directive 2.620, the WS' Aviation Operations and Safety Manual and its amendments, Title 14 CFR, and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137. Aerial operations would occur in remote locations; therefore, the risk to the public from aviation operations or accidents would be minimal. The WS program aircraft-use policy helps ensure the program conducts aerial shooting in a safe and environmentally sound manner, in accordance with federal and state laws. No adverse effects to human safety have occurred from WS' implementation of Alternative 1 in the State from FY 2012 through FY 2016. Based on the use patterns of methods available to address damage caused by coyotes and red fox, implementation of Alternative 1 would comply with Executive Order 12898 and Executive Order 13045. If WS implements Alternative 2, the risks to human safety would likely be similar to Alternative 1 because the SDGFP is likely to conduct their own aerial operations or hire private entities to conduct those activities within the State.

In conclusion, implementation of Alternative 1 would not result in cumulatively significant environmental impacts on any of the issues analyzed in this EA (see Section 2.1) based on past, present, and/or reasonably foreseeable future actions. If WS implement Alternative 1, all activities would comply with relevant laws, regulations, policies, orders, procedures, and WS' directives. When implementing Alternative 1, WS would also implement those SOPs discussed in Section 2.3. In addition, WS would review this EA periodically to ensure activities and their impacts remain consistent with the activities and impacts analyzed in this EA. Monitoring activities would ensure that program effects occurred within the limits of evaluated/anticipated activities. Monitoring involves review of the EA for all of the issues evaluated in Chapter 3 to ensure that the activities and associated impacts have not changed substantially over time.

CHAPTER 4: RESPONSES TO PUBLIC COMMENTS

4.1 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 *Capital Journal* newspaper from February 15, 2018 through February 17, 2018 and the Rapid City Journal newspaper on February 16, 2018, February 21, 2018, and February 24, 2018. WS also made the EA available to the public for review and comment on the APHIS website on February 13, 2018 and on the regulations.gov website beginning on February 12, 2018. 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 March 23, 2018. During the public comment period, WS received 10 comment responses on the draft EA. Chapter 4 summarizes the comment responses WS received and provides WS' responses to the comments.

Comment – Commenter opposes any involvement by WS

Response: WS developed alternative approaches (see Section 2.2) to meet the need for action (see Section 1.4) and to address the identified issues associated with managing livestock predation caused by coyotes and red fox (see Section 2.1). This EA analyzed a no involvement by the WS program alternative (Alternative 2; see Section 2.2.1 of the EA). If WS implemented Alternative 2, the WS program would no longer incorporate aerial operations into the program to manage wildlife damage administered by the SDGFP. Section 3.2 analyzes the environmental consequences of each of the alternatives in comparison to determine the extent of actual or potential impacts on the issues, including the no involvement by WS alternative. Based on the analyses of the alternatives that were developed to address those issues analyzed in detail within the EA, including individual and cumulative impacts of the alternatives, the WS program will issue a decision for the final EA.

Comment – Force agriculture producers to use fences, guard animals, lights, noise, and other methods. Livestock producers should be responsible for protecting livestock using electric fencing, guard animals, and fencing. WS should consider the use of other species-specific methods, including on-the-ground methods.

Response: Livestock producers use many non-lethal methods to reduce predation (*e.g.*, see 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). As discussed in Section 1.5, the cultural practices or the methods that livestock producers use or do not use to prevent or alleviate livestock predation are outside the scope of the EA because of the need for action (see Section 1.4). The SDGFP administers their own program to manage wildlife damage in the State and the aerial activities that WS could conduct would be one method that personnel with the SDGFP could use and/or recommend when they address a request for assistance. Therefore, the need for action identified by WS is whether to assist the SDGFP by conducting aerial operations using aircraft owned or leased by WS and the associated personnel (*i.e.*, pilot and crewmembers) because that is the only activity requested by the SDGFP.

Comment – Opportunistic shooting of coyotes by farmers is the most effective approach to managing livestock predation

Response: As discussed in Section 1.5, the cultural practices or the methods that livestock producers use or do not use to prevent or alleviate livestock predation are outside the scope of the EA because of the need for action (see Section 1.4). Before WS could conduct activities, the appropriate landowner or manager would have to sign a MOU, work initiation document, cooperative service field agreement, or another similar document, which would allow WS to conduct aerial activities on property they own and/or manage. Therefore, the entity requesting assistance would determine what methods they feel are appropriate to managing the damage they are experiencing. In addition, the damage a livestock producer is experiencing has risen to a threshold that they request assistance (see Section 1.4).

Comment – WS should use cheaper and more humane methods to address red fox

Response: The commenter references methods to managing damage associated with fox identified by Phillips and Schmidt (1994) that the commenter felt were cheaper than using aircraft to shoot red fox and are just as effective. Specifically, the commenter suggests the use of exclusion, cultural methods, frightening methods, and toxicants. As discussed in Section 1.5, the cultural practices or the methods that livestock producers use or do not use to prevent or alleviate livestock predation are outside the scope of the EA because of the need for action (see Section 1.4). However, livestock producers use many non-lethal methods to reduce predation, including those identified by Phillips and Schmidt (1994) (*e.g*., see 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 actions, decisions, and program implementation of the SDGFP are outside the authority of WS, including the actions, decisions, and implementation of the SDGFP program to manage wildlife and wildlife damage in the State. Therefore, the methods personnel with the SDGFP use and/or recommend when responding to a requesting for assistance are outside the scope of this EA. The aerial activities that WS could conduct would be one method that personnel with the SDGFP could use and/or recommend when they address a request for assistance.

Comment – The EA should include a cost and efficacy analysis between aerial operations and other methods

Response: WS considered the cost and efficacy of aerial operations in the EA. As discussed in Section 1.4.9, cost effectiveness may be a consideration; however, the cost of conducting activities may sometimes be secondary because of overriding environmental, legal, human health and safety, animal welfare, or other concerns. In addition, the CEQ does not require a formal, monetized cost benefit analysis to comply with the NEPA. Cain et al. (1972) rated many of the methods available to manage livestock predation caused by predators and 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. In addition, conducting aerial operations could be a part of an integrated methods approach that personnel with the SDGFP use to manage livestock predation or could be a method used after other methods prove to be ineffective at preventing livestock predation.

Comment – There are no reasons why taxpayers should pay for aerial operations. Conducting aerial operations would be a waste of government money.

Response: As discussed in Section 2.2.2, WS considered an alternative that would have required people requesting assistance pay for all the costs associated with aerial operations (*i.e*., no taxpayer money). For the reasons provided in Section 2.2.2, WS did not consider the alternative in detail. In addition, funding for WS' activities could occur from federal appropriations, through state funding, through tribal funding, and through cooperative service agreements with individual property owners or managers. In those cases, federal officials, state officials, tribal entities, and/or property owners/managers have made the decision to provide funding for damage management activities and have allocated funds for such activities.

Comment – Cut the funding for the WS program to zero

Response: Damage management activities are an appropriate sphere of activity for government programs because 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 livestock predation associated with coyotes and red fox in the State (see Alternative 2). 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 2, the WS program would not provide assistance; however, the SDGFP and/or other entities could conduct aerial operations in the absence of the WS program.

Comment – Donate money for aerial operations to agriculture producers to upgrade fences

Response: Funding for WS' activities could occur from federal appropriations, through state funding, through tribal funding, and/or through cooperative service agreements with individual property owners or managers. In those cases, federal officials, state officials, tribal officials, and/or property owners/managers have made the decision to provide funding for damage management activities and have allocated funds for such activities. As discussed in Section 1.4.5, the SDGFP has requested the assistance of WS with conducting aerial operations to manage livestock predation associated with coyotes and red fox; therefore, the SDGFP has determined a need to conduct aerial operations exists within the State. Therefore, WS would have no authority to donate money to livestock producers to upgrade their fencing.

Comment – WS promotes the use of lethal methods to make money and kills wildlife for no reason

Response: As discussed in Section 1.4.1, the SDGFP has requested that WS incorporate WS' aircraft and pilots into the damage management program administered by the SDGFP to reduce economic losses associated with coyotes and red fox killing livestock in the State. Under South Dakota Codified Law 41-9-39.2, the SDGFP can contract with entities to conduct aerial operations to control fox and coyotes pursuant to the Airborne Hunting Act (Public Law 92-159) and South Dakota Codified Law 40-36-9. Therefore, the need for action discussed in Section 1.4.5 is whether WS should assist the SDGFP by conducting aerial operations using aircraft owned or leased by WS and the associated personnel (*i.e.*, pilot and crewmembers). Therefore, the only method that WS is considering in this EA is the use of aircraft and the associated pilots and crewmembers to perform aerial operations as requested by the SDGFP. The use of other methods or approaches by WS is outside the scope of this EA.

Comment – The EA should quantify or monetize the non-use values of coyotes and red fox

Response: Section 2.1.1 and Section 3.2.1 address the potential effects from WS' activities on the public's aesthetic enjoyment of animals and the potential effects of WS' activities on consumptive and non-consumptive uses associated with coyotes and red fox. However, no standard exists for quantifying or monetizing the non-use values of coyotes and/or red fox. In addition, quantifying or monetizing the non-use values of coyotes and red fox would be difficult because people would place different values on animals and would likely use different methods to value animals. For example, 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 EA does discuss the economic contribution of wildlife recreation in South Dakota. In 2011, the USFWS and the United States Department of Commerce (2011) found 662,000 people participated in wildlife-associated recreation in South Dakota, including people that participated in hunting, fishing, and wildlife watching. In total, people spent over $1.2 billion on wildlife recreation in South Dakota during

2011 (USFWS and the United States Department of Commerce 2011). However, the information does not provide a monetary value for individual animals or specific species, such as coyotes or red fox.

Comment – WS cannot contain the noise pollution caused by aircraft, which will spill over to surrounding areas

Response: The amount of time WS' spends conducting aerial operations would vary depending on many factors. The primary factors would include 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. In general, WS spends relatively little time over any one area when conducting aerial operations. Flights over a particular area are often of short duration and frequency. On average, WS spent less than 10 minutes per square mile conducting aerial operations on those properties where WS conducted aerial operations from FY 2012 through FY 2016. On average, WS conducted aerial operations on 3.9% of the total land area of the State annually from FY 2012 through FY 2016. WS anticipates continuing to conduct aerial activities on a very small percentage of the land area of the State, which would not expose the public to the noise associated with WS' aircraft. In addition, the use of firearms from aircraft by WS would generally occur in remote areas where tree cover and vegetation allows for visibility of target animals from the air. Because of the remote locations in which the WS program conducts aerial operations, the exposure of the public to the noise associated with aircraft would be minimal.

Comment – The use of aircraft will cause air pollution

Response: The effects of WS' activities on air quality, global climate change, and greenhouse gas emissions occur in Section 2.1.2.

Comment – WS should notify property owners before conducting activities

Response: In general, the property owner and/or manager would be aware of when aerial operations would occur on property they own and/or manage.

Comment – Removing a certain fitness class of coyotes or red fox will have different effects

Response: As discussed in Section 2.2.2, livestock predation appears to be primarily associated with the higher food demands associated with provisioning pups. For example, Till and Knowlton (1983) indicated that livestock depredation in the spring and summer was caused by territorial adult coyotes with pups to feed. 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. Seidler and Gese (2012) found similar results. Therefore, livestock predation appears to be more about the need to feed pups than the fitness of the animals.

Comment – The EA should address the industries that livestock predation indirectly affects

Response: Section 1.4.2 discusses the contributions of livestock to the economy of South Dakota and Section 1.4.3 discusses livestock predation by coyotes and red fox in South Dakota. Livestock lost to predation likely indirectly affects certain industries within the State; however, information related to those indirect affects is not available or the information available is limited. In addition, many factors complicate the process of deriving indirect effects of livestock predation on related industries, such as different classes of livestock having different values, types of livestock lost, and the final disposition of the animal if predation had not occurred. As described by the CEQ (2007), the intent of an EA is to provide brief but sufficient evidence and analysis to determine whether to prepare an EIS, aid in complying with the NEPA when an EIS is not necessary, and to facilitate preparation of an EIS when one is necessary. Providing additional analysis in the EA on the indirect effects of livestock predation on related industries would not be necessary for WS to comply with the NEPA.

Comment – The EA should discuss how a decrease in the coyote population would affect revenue generated from hunting

Response: As discussed in Section 3.2.1, based on population models, the cumulative known lethal removal of coyotes has not reached a magnitude that would cause the coyote population to decline in the State. In addition, information on the amount of money that individual people spend to hunt coyotes in South Dakota in not currently available. On average, the program administered by the SDGFP to manage wildlife damage in the State has lethally removed approximately 28% of the cumulative known removal of coyotes per year from 2011 through 2016. Therefore, on average, hunters and/or trappers have lethally removed approximately 72% of the cumulative known removal of coyotes in the State per year. In South Dakota, the SDGFP is responsible for managing wildlife populations within the State, including the populations of coyotes and red fox. In support of their program to manage wildlife damage, the SDGFP has requested the assistance of WS with conducting aerial operations to manage livestock predation associated with coyotes and red fox; therefore, the SDGFP has determined a need to conduct aerial operations exists within the State. Aerial operations conducted by WS would occur at the request of the SDGFP and/or a tribal entity; therefore, any removal of coyotes by WS during aerial operations would occur at the discretion of the SDGFP and/or a tribal entity. Therefore, the SDGFP could adjust allowed removal in the State and a tribal entity could adjust allowed removal on tribal property, including removal by WS during aerial operations, if they deemed it necessary. Based on the available information, WS concludes the implementation of Alternative 1 would not limit recreational opportunities within the State and would not reduce the ability of people to harvest coyotes in the State.

Comment – WS should prepare an EIS

Response: As discussed in Section 1.2.1, WS is preparing this EA to evaluate alternative means of achieving the objectives of WS and to determine whether the potential environmental effects caused by the alternatives might be significant, requiring the preparation of an EIS. As described by the CEQ (2007), the intent of an EA is to provide brief but sufficient evidence and analysis to determine whether to prepare an EIS, aid in complying with the NEPA when an EIS is not necessary, and to facilitate preparation of an EIS when one is necessary. The CEQ (2007) further states, "*The EA process concludes with either a Finding of No Significant Impact…or a determination to proceed to preparation of an EIS*".

Comment – Aerial operations will cause the extinction of red fox or result in a threatened status of red fox

Response: As discussed in Section 3.2.1, available information indicates the cumulative annual mortality of red fox from all known sources would not reach an intensity level or magnitude that would cause long-term suppression or eradication of red fox within the State. By monitoring activities and implementing SOPs, WS would be able to identify and respond to changes in the red fox population that could result from natural processes and human generated changes, including those changes occurring from sources other than WS. If WS determines that a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts warrant a new or additional analysis, WS would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, WS can evaluate and adjust activities as changes to populations occur over time.

Comment – Removing red fox will cause the release of the populations of their prey species and the prey species will cause damage. Removing red fox during aerial operations would cause a negative effect on the surrounding ecosystem.

Response: Section 3.2.1 discusses the potential for activities to cause trophic cascades, including mesopredator release, and the potential for activities to affect biodiversity and ecosystem resilience.

Comment – Conducting aerial surveys for coyotes and red fox are ineffective

Response: The commenter discusses limitations associated with conducting aerial surveys for coyotes and red fox. The commenter references a paper by Sargeant et al. (1975) that discusses aerial surveys for red fox in North Dakota and a paper by Jachmann (2002) that compares aerial counts with ground counts for large African herbivores. WS reviewed Sargeant et al. (1975) and Jachmann (2002) for information relevant to the activities that WS could conduct if WS implemented Alternative 1. However, the commenter and the papers by Sargeant et al. (1975) and Jachmann (2002) discuss aerial surveys that relate to estimating wildlife populations. If WS implements Alternative 1, WS would not be conducting aerial surveys to estimate populations of coyotes and/or red fox; therefore, many of the limitations associated with accurately assessing a wildlife population are not applicable to the aerial operations WS could conduct. Section 1.4.9 discusses the effectiveness of aerial operations.

Comment – Tribal governments should be able to coordinate directly with WS

Response: Tribal governments can coordinate directly with WS when the tribal government determines WS' assistance is appropriate. WS reworded several areas of the EA to reflect that tribal entities can request assistance from WS directly.

Comment – Concern about the familiarity of personnel with property boundaries to ensure WS does not conduct activities on non-authorized lands

Response: This was a concern that WS addressed in Section 2.1.2.

Comment – WS should fully consider the implementation of Alternative 1 but WS' personnel would verify predation before conducting activities alternative

Response: WS did not carry this alternative forward for further analysis in Chapter 3 for the reasons provided in Section 2.2.2.

Comment – WS' personnel may misidentify swift fox as coyote pups and unintentional removal of swift fox could be detrimental to swift fox restoration efforts

Response: Section 3.2.2 discusses the potential effects of conducting aerial operations on the populations of non-target species, including swift fox. Between FY 2012 and FY 2016, WS' personnel did not lethally remove any non-target animals during aerial operations in South Dakota, including swift fox. Despite the similarities in appearance, WS does not anticipate any unintentional take of swift fox to occur during aerial operations conducted by WS based on the information provided in Section 3.2.2.

Comment – There should be a limit on the number of coyotes and red fox killed

Response: In South Dakota, the SDGFP is responsible for managing wildlife populations within the State, including the populations of coyotes and red fox. On properties owned and/or managed by a tribe, the tribal government would be responsible for managing wildlife populations, including coyote and red fox populations. In support of their program to manage wildlife damage, the SDGFP has requested the assistance of WS with conducting aerial operations to manage livestock predation associated with coyotes and red fox; therefore, the SDGFP has determined a need to conduct aerial operations exists within the State. Aerial operations conducted by WS would occur at the request of the SDGFP; therefore, any removal of coyotes or red fox by WS during aerial operations would occur at the discretion of the SDGFP. Therefore, the SDGFP could adjust allowed removal in the State, including removal by WS during aerial operations, if they deemed it necessary. Similarly, aerial operations conducted by WS on tribal land would only occur after WS receives a request for such assistance by a tribal government. WS would only conduct activities after WS and the tribe requesting assistance signed a MOU, work initiation document, cooperative service field agreement, or another similar document. On tribal lands, the tribal government would be responsible for managing wildlife resources on their land. Therefore, any removal of coyotes or red fox by WS during aerial operations on tribal land would occur at the discretion of the tribal government. Therefore, the tribal government could adjust allowed removal on tribal land, including removal by WS during aerial operations, if they deemed it necessary.

CHAPTER 5: LIST OF PREPARERS AND PERSONS CONSULTED

5.1 LIST OF PREPARERS

John Paulson, State Director	USDA/APHIS/WS
Kari Shea, MIS Data Technician	USDA/APHIS/WS
Ryan Wimberly, Staff Wildlife Biologist	USDA/APHIS/WS

5.2 LIST OF REVIEWERS AND PERSONS CONSULTED

Keith Fisk, Wildlife Damage Program Administrator	SDGFP
Ron Skates, Tribal Liaison	SDGFP
Shelly Deisch, United States Forest Service Liaison	SDGFP
Scott Larson, Field Supervisor	USFWS
Meghan Dinkins, Biologist	United States Forest Service
Kerry Burns, Wildlife Biologist	United States Forest Service
Gary Littauer, Assistant Regional Director (retired)	USDA/APHIS/WS
Anthony Decino, Pilot	USDA/APHIS/WS
Daniel Turgeon, Biological Science Technician	USDA/APHIS/WS

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.

Allen, B. L., Allen, L. R., Andrén, H., Ballard, G., Boitani, L., Engeman, R. M., Fleming, P. J. S., Haswell, P. M., Kowalczyk, R., Linnell, J. D. C., Mech, L. D., Parker, D. M., 2017. Can we save large carnivores without losing large carnivore science? Food Webs 12:64–75.

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. 1987. Panel report on the colloquium on recognition and alleviation of animal pain and distress. Journal of the American Veterinary Medical Association 191:1186–1189.

AVMA. 2013. AVMA guidelines on euthanasia. American Veterinary Medical Association. 102 pages.

Ames, D. R., and L. A. Arehart. 1972. Physiological response of lambs to auditory stimuli. Journal of Animal Science 34:997-998.

Andersen, D. E., O. J. Rongstad, and W. R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. Condor 91:296-299.

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.

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.

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.

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.

Beaver, B. V., W. Reed, S. Leary, B. McKiernan, F. Bain, R. Schultz, B. T. Bennett, P. Pascoe, E. Shull, L. C. Cork, R. Francis-Floyd, K. D. Amass, R. Johnson, R. H. Schmidt, W. Underwood, G.W. Thorton, and B. Kohn. 2001. 2000 Report of the AVMA Panel on Euthanasia. Journal of the American Veterinary Association 218:669–696.

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.

Bekoff, M., and M. C. Wells. 1982. Behavioral ecology of coyotes: social organization, rearing patterns, space use, and resource defense. Z. Tierpsychol. 60:281-305.

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.

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.

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.

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.

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.

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.

Borg, E. 1979. Physiological aspects of the effects of sound on man and animals. Acta Oto-laryngologica, Supplement 360:80-85.

Boyce, P. S. 1998. The social construction of bereavement: an application to pet loss. Thesis, University of New York.

Brashares, 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.

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.

California Department of Fish and Game. 1991. Final environmental document - bear hunting. Title 14 Calif. Code of Regs. Calif. Dept. of Fish and Game, State of California, April 25, 1991. 337 pp.

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.

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.

Chitty, D. 1967. The natural selection of self-regulatory behavior in animal populations. Proceedings of the Ecological Society 2:51-78.

Clark, F. W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management 36:343-356.

Collins, C., and R. Kays. 2011. Causes of mortality in North American populations of large and medium-sized mammals. Animal Conservation (2011) 1-10.

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 W. M. Longhurst. 1975. The effects of control on coyote populations. Univ. Calif., Div. Agric. Sci. Bull. 1872. 37 pp.

Connolly, G. E., and B. W. O'Gara. 1987. Aerial hunting takes sheep-killing coyotes in Western Montana. Proceedings of the Great Plains Wildlife Damage Control Workshop 8:184-188.

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. 2002. Resolving human-wildlife conflicts: the Science of Wildlife Damage Management. Lewis Publ., New York, New York.

CEQ. 2007. A citizen's guide to the NEPA: Having your voice heard. Council on Environmental Quality, Executive Office of the President. 55 pp.

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.

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.

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.

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 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.

Decision Innovation Solutions. 2014. 2014 South Dakota Ag economic contribution study. 50 pp.

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.

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.

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.

Diamond, J. 1992. Must we shoot deer to save nature? Natural History. New York, August 2.

Dowd Stukel, E., ed. 2011. Conservation assessment and conservation strategy for swift fox in the United States – 2011 Update. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 100 pp.

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.

Engeman, R. M., L. R. Allen, and B. L. Allen. 2017. Study design concepts for inferring functional roles of mammalian top predators. Food Webs 12:56-63.

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.

Federal Aviation Administration. 2017. Aviation gasoline - About aviation gasoline. Federal Aviation Administration website. https://www.faa.gov/about/initiatives/avgas/. Accessed June 28, 2017.

Fisk, K. J. 2017. Wildlife Damage Management Program - Fiscal Year 2016. Wildlife Division Report Number 2016-04. South Dakota Game, Fish, and Parks, Pierre, South Dakota. 44 pp.

Fisk, K. J. 2018. Wildlife Damage Management Program - Fiscal Year 2017. Wildlife Division Report Number 2017-09. South Dakota Game, Fish, and Parks, Pierre, South Dakota. 46 pp.

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, 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.

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.

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., 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.

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.

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.

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.

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., 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.

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.

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.

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.

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.

Hoffmann, M., and C. Sillero-Zubiri. 2016. *Vulpes vulpes*. The IUCN Red List of Threatened Species 2016: e.T23062A46190249. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T23062A46190249.en. Accessed January 24, 2018.

Honness, K., M. Phillips, and K. Kunkel. 2008. Swift fox restoration in west central South Dakota. Final Progress Report (2003-2007). United States Fish and Wildlife Service, Region 6, Private Stewardship Grants Program. 92 pp.

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.

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.

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.

Jachmann, H. 2002. Comparison of aerial counts with ground counts for large African herbivores. Journal of Applied Ecology 39:841-852.

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.

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.

Kennelly, J. J., and B. E. Johns. 1976. The estrous cycle of coyotes. Journal of Wildlife Management 40:272-277.

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, 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.

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.

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.

Lane, P. A. 2017*a*. A review of the trophic cascade concept using the lens of the loop analysis: "The truth is the whole". Food Webs 13:1-11.

Lane, P. A. 2017*b*. Assumptions about trophic cascades: The inevitable collision between reductionist simplicity and ecologic complexity. Food Webs 13:12-26.

Lefrancois, G. R. 1999. The Lifespan. Sixth edition. Wadsworth Publishing Company, Belmont, California, USA.

Levi, T., and C. Wilmers. 2012. Wolves–coyotes–foxes: a cascade among carnivores. Ecology 93:921–929.

Longmire, C. L. 2015. Animal damage control services: Customer satisfaction survey results. ID# HD-5-15.AMS. South Dakota Game, Fish, and Parks, Pierre, South Dakota. 63 pp.

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.

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.

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.

Messier, F., and C. Barrette. 1982. The social system of the coyote (*Canis latrans*) in a forested habitat. Can. J. Zool. 60:1743-1753.

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.

Miller, A. 1995*a*. Coyote (*Canis latrans*). https://www3.northern.edu/natsource/MAMMALS/Coyote1.htm. Accessed October 25, 2017.

Miller, L. A. 1995*b*. 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&M University, San Angelo, Texas.

Miller, B., B. Dugelby, D. Foreman, C. Martínez del Río, R. Noss, M. Phillips, R. Reading, M. E. Soulé, J. Terborgh, and L. Willcox. 2001. The importance of large carnivores to healthy ecosystems. Endangered Species UPDATE 18:202–209.

Miller, B. J., H. J. Harlow, T. S. Harlow, D. Biggins, and W. J. Ripple. 2012. Trophic cascades linking wolves (*Canis lupus*), coyotes (*Canis latrans*), and small mammals. Canadian Journal of Zoology 90:70–78.

Mitchell, B. R., M. M. Jaeger, and R. H. Barrett. 2004. Coyote depredation management: current methods and research needs. Wildlife Society Bulletin 32:1209-1218.

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., G. Lynch, and J. Theade. 1984. Circumstances associated with predation rates on sheep and goats. J. Range Manage. 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. 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. 2016. South Dakota rank in U.S. agriculture. South Dakota Department of Agriculture website. https://sdda.sd.gov/office-of-the-secretary/publications/pdf/2016%20SD%20rankings%20sheet.pdf. Accessed October 26, 2017.

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.

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.

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.

Orians, G. H., P. A. Cochran, J. W. Duffield, T. K. Fuller, R. J. Gutierrez, W. M. Haneman, F. C. James, P. Kareiva, S. R. Kellert, D. Klein, B. N. McLellan, P. D. Olson, and G. Yaska. 1997. Wolves, Bears, and their Prey in Alaska: Biological and Social Challenges in Wildlife Management. National Research Council, Washington D.C.

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.

Paquet, P. C., and L. N. Carbyn. 2003. Gray wolf. Pp 482-510 *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.

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.

Pence, D. B., L. A. Windberg, B. C. Pence, and R. Sprowls. 1983. The epizootiology and pathology of sarcoptic mange in coyotes, *Canis latrans*, from South Texas. Journal of Parasitology 69:1100-1115.

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.

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.

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.

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.

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, W. B. 1961. Population changes of carnivores in some coyote-control areas. Journal of Mammalogy 42:510–515.

Ross, C. B., and J. Baron-Sorensen. 1998. Pet loss and human emotion: guiding clients through grief. Accelerated Development, Incorporation, Philadelphia, Pennsylvania, USA.

Roy, L. D., and M. J. Dorrance. 1985. Coyote movements, habitat use, and vulnerability in central Alberta. Journal of Wildlife Management 49:307-313.

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.

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.

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.

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.

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.

Sheikh, P. A., M. L. Corn, J. A. Leggett, and P. Folger. 2007. Global climate change and wildlife. Congressional Research Service Report for Congress. 6 pp.

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).

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.

Smith, D. W., R. O. Peterson, D. R. MacNulty, and M. Kohl. 2016. The big scientific debate: Trophic cascades. Yellowstone Science 24:70–71.

South Dakota Department of Agriculture. 2012. South Dakota Agriculture – Facts and Impacts. https://sdda.sd.gov/office-of-the-secretary/agriculture-industry/. Accessed May 15, 2017.

SDGFP. 2014. South Dakota Wildlife Action Plan. Wildlife Division Report 2014-03. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 583 pp.

SDGFP. 2017*a*. Agency information: About us. South Dakota Game, Fish, and Parks website. http://gfp.sd.gov/agency/information/default.aspx. Accessed October 26, 2017.

SDGFP. 2017*b*. Hunting areas. South Dakota Game, Fish, and Parks website. http://gfp.sd.gov/hunting/areas/default.aspx. Accessed October 26, 2017.

South Dakota Office of School and Public Lands. 2016. July 1, 2015 – June 30, 2016 Annual Report. South Dakota Office of School and Public Lands, Pierre, South Dakota. 22 pp.

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.

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.

The Wildlife Society. 2015. Standing position statement: wildlife damage management. The Wildlife Society, Washington., D.C. 2 pp.

Thomas, K. 1997. Red fox (*Vulpes vulpes*). https://www3.northern.edu/natsource/MAMMALS/Redfox1.htm. Accessed October 26, 2017.

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., and F. F. Knowlton. 1983. Efficacy of denning in alleviating coyote depredations upon domestic sheep. Journal of Wildlife Management 47:1018-1025.

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.

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. 2013. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services Strategic Plan (2013-2017). United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Riverdale, Maryland. 18 pp.

USDA. 2015. Final Environmental Impact Statement: Feral swine damage management: A national approach. USDA/APHIS/WS, Riverdale, Maryland, USA.

United States Environmental Protection Agency. 2000. Introduction to phytoremediation. EPA/600/R-99/107, Office of Research and Development, Washington, D.C., USA.

United States Environmental Protection Agency. 2016. Climate change on ecosystems. https://www.epa.gov/climate-impacts/climate-impacts-ecosystems. Accessed October 11, 2016.

USFWS. 2007. National bald eagle management guidelines. https://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf. Accessed December 1, 2016.

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 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.

Vincent, C. H., L. A. Hanson, and J. P. Bjelopera. 2014. Federal land ownership: Overview and data. Congressional Research Service. 28 pp.

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.

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.

Wallach, A. D., I. Izhaki, J. D. Toms, W. J. Ripple, and U. Shanas. 2015. What is an apex predator? Oikos 124:1453-1461.

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.

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.

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.

Windberg, L. A., and F. F. Knowlton. 1988. Management implications of coyote spacing patterns in southern Texas. Journal of Wildlife Management 52:632-640.

Zasloff, R. L. 1996. Human-animal interactions. Special Issue. Applied Animal Behaviour Science. 47: 43-48.