ENVIRONMENTAL ASSESSMENT

Managing Livestock Predation by Coyotes, Dogs and Red Foxes in the Commonwealth of Virginia

Prepared by:

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

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ACRONYMS

AFWA	Association of Fish and Wildlife Agencies
APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CSA	Cooperative Service Agreement
CY	Calendar Year
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FDA	U.S. Department of Health and Human Services, Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FR	Federal Register
FY	Fiscal Year
MIS	Management Information System
MOU	Memorandum of Understanding
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NWRC	U.S. Department of Agriculture, Animal and Plant Health Inspection Service, National Wildlife Research Center
USDA	U.S. Department of Agriculture
USFWS	U.S. Department of the Interior, U.S. Fish and Wildlife Service
SOPs	Standard Operating Procedures
VDACS	Virginia Department of Agriculture and Consumer Services
VDGIF	Virginia Department of Game and Inland Fisheries
WS	U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services

CHAPTER 1: PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

Across the United States, habitat has been substantially changed as human populations expand and land is used for human needs. These human uses and needs often compete with the needs of animals which increases the potential for conflicting human/animal interactions. This Environmental Assessment (EA) evaluates the potential environmental effects of alternatives for WS involvement in managing damage and threats of damage to livestock associated with coyotes, dogs and red foxes in Virginia. The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program is the federal agency authorized to protect American resources from damage associated with wildlife (the Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 426c)). Human/animal conflict issues are complicated by the wide range of public responses to animals and animal damage. What may be unacceptable damage to one person may be a normal cost of living with nature to someone else. The relationship in American culture of values and damage can be summarized in this way:

Animals have either positive or negative values, depending on varying human perspectives and circumstances (Decker and Goff 1987). Animals are generally regarded as providing economic, recreational and aesthetic benefits, and the mere knowledge that animals exist is a positive benefit to many people. However, the activities of some animals may result in economic losses to agriculture and damage to property. Sensitivity to varying perspectives and values is required to manage the balance between human and animal needs. In addressing conflicts, managers must consider not only the needs of those directly affected by damage but a range of environmental, sociocultural and economic considerations as well.

WS' activities are conducted to prevent or reduce animal damage to agricultural, industrial, and natural resources, and to property, livestock, and threats to public health and safety on private and public lands in cooperation with federal, state and local agencies, tribes, private organizations, and individuals. The WS program uses an integrated approach (WS Directive 2.105) in which a combination of methods may be used or recommended to reduce damage. Program activities are not based on punishing offending animals but are conducted to reduce damage and risks to human and livestock health and safety, and are used as part of the WS Decision Model (Slate et al. 1992).

WS is a cooperatively funded, service-oriented program that receives requests for assistance with damage caused by animals from private and public entities, including tribes and other governmental agencies. As requested, WS cooperates with land and animal management agencies to reduce damage effectively and efficiently in accordance with applicable federal, state, and local laws and Memoranda of Understanding (MOUs) between WS and other agencies.

WS chose to prepare this EA to facilitate planning, interagency coordination and the streamlining of program management and to clearly communicate with the public the analysis of individual and cumulative impacts. In addition, this EA has been prepared to evaluate and determine if there are any potentially significant or cumulative impacts from the proposed damage management program. Pursuant to the NEPA and the Council on Environmental Quality (CEQ) regulations, WS is preparing this EA[1] to document the analyses associated with proposed federal actions and to inform decision-makers and the public of reasonable alternatives capable of avoiding or minimizing significant effects. This EA will also

[1] The CEQ defines an EA as documentation that "...(1) briefly provides sufficient evidence and analysis for determining whether to prepare an [Environmental Impact Statement]; (2) aids an agency's compliance with NEPA when no environmental impact statement is necessary; and (3) facilitates preparation of an Environmental Impact Statement when one is necessary" (Council on Environmental Quality 2007).

serve as a decision-aiding mechanism to ensure that the policies and goals of the NEPA are infused into the actions of the agency.

1.2 PURPOSE

WS continues to receive requests for assistance to resolve or prevent damage occurring to livestock from coyotes (*Canis latrans*), dogs (*Canis lupus familiaris*) and red foxes (*Vulpes vulpes*) in Virginia. This EA will assist in determining if the proposed management of coyote, dog and red fox damage could have a significant impact on the human environment based on previous activities conducted and based on the anticipation of receiving additional requests for assistance. Because the goal of WS is to conduct a coordinated program in accordance with plans and objectives developed to reduce damage, and because this goal and these objectives are to provide services when requested, within the constraints of available funding and workforce, it is conceivable that additional damage management efforts could occur. Thus, this EA anticipates those additional efforts and the analyses are intended to apply to actions that may occur in any locale and at any time within Virginia as part of a coordinated program.

Changes in the need for action and the affected environment have prompted WS to initiate this new analysis to manage coyote, dog and red fox damage in the Commonwealth. This EA will address more recently identified changes and will assess the potential environmental impacts of program alternatives based on a new need for action.

1.3 NEED FOR ACTION

Some species of animals have adapted to and have thrived in human altered habitats. Those species, in particular, are often responsible for the majority of conflicts between people and animals. Those conflicts often lead people to request assistance with reducing damage or threats. Animals can have either positive or negative values depending on the perspectives and circumstances of individual people. In general, people regard animals as providing economic, recreational, and aesthetic benefits. Knowing that animals exist in the natural environment provides a positive benefit to some people. However, activities associated with these animals may result in economic losses to agricultural resources, natural resources, property, and threaten human safety. Therefore, an awareness of the varying perspectives and values is required to balance the needs of people and the needs of animals. When addressing damage or threats of damage caused by animals, damage management professionals must consider not only the needs of those people directly affected by damage but a range of environmental, sociocultural, and economic considerations as well.

Both sociological and biological carrying capacities must be applied to resolve damage problems. The animal acceptance capacity, or cultural carrying capacity, is the limit of human tolerance for animals or the maximum number of a given species that can coexist compatibly with local human populations. The biological carrying capacity is the ability of the land or habitat to support healthy populations of animals 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 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 animal acceptance capacity. The available habitat may have a biological carrying capacity to support higher populations however, in many cases; the animal acceptance capacity is lower or has been reached. Once the animal acceptance capacity is reached or exceeded, people begin to implement population or damage management to alleviate damage or address threats to human health and safety.

The threat of damage or loss of resources is often sufficient for individual actions to be initiated and the need for damage management is derived from the specific threats to resources. Those species have no intent to do harm. They utilize habitats (e.g., reproduce, forage) where they can find a niche. If their activities result in lost economic value of resources or threaten human safety, people characterize this as damage. When damage exceeds or threatens to exceed an economic threshold and/or poses 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 can be based on many factors (e.g., economic, social, aesthetics). Therefore, how damage is defined can often be unique to an individual person, and damage occurring to one individual may not be considered damage by another individual. However, the term "damage" is consistently used to describe situations where an individual person has determined the losses associated with animals is actual damage requiring assistance (i.e., has reached an individual threshold). The term "damage" is most often defined as economic losses to resources or threats to human safety. However, damage could also include a loss in aesthetic value and other situations where the actions of animals are no longer tolerable to an individual person.

Managing damage caused by animals is often based on balancing animal populations and human perceptions in a struggle to preserve rare species, regulate species populations, oversee consumptive uses of animals, and conserve the environment that provides habitat. Animals are regarded as having aesthetic, ecological, economic, educational, nutritional, scientific and socio-cultural values (Chardonnet et al. 2002), and there is enjoyment in knowing species exist and contribute to natural ecosystems (Decker et al. 2001). However, when the presence of an adaptable and opportunistic species is combined with human expansion, land management conflicts often develop.

Predators add an aesthetic component to the environment, provide essential ecological functions, sometimes provide opportunities for recreational hunting and trapping, and provide people with a connection with nature. Many people, even those people experiencing damage, consider the predators addressed in this EA to be a charismatic and valuable component of their environment. However, tolerance differs among individuals.

The need for action to manage damage and threats of predation to livestock associated with coyotes, dogs, and red foxes in Virginia arises from requests for assistance[2] received by WS to reduce and prevent damage to livestock. Table 1.1 lists the number of requests for assistance with managing damage or threats of damage to livestock associated with coyotes, dogs or red foxes in Virginia from the federal fiscal year (FY)[3] 2009 through FY 2013.

[2] WS only conducts damage management after receiving a request for assistance. Before initiating damage activities, a Memorandum of Understanding, cooperative service agreement, or other comparable document must be signed between WS and the cooperating entity which lists all the methods the property owner or manager will allow to be used on property they own and/or manage.
[3] The federal fiscal year begins on October 1 and ends on September 30 the following year.

Table 1.1 - Requests for assistance with managing damage or threats of damage to livestock associated with coyotes, dogs or red foxes received by WS in Virginia, FY 2009–2013[1].

Livestock Resource[2]	Predator Species	Projects				
		FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Cows	Coyote	150	108	139	102	132
	Dog	101	60	80	62	58
	Red fox	0	0	0	0	1
Sheep	Coyote	104	90	106	107	125
	Dog	75	38	40	38	34
	Red fox	10	12	18	20	20
Goats	Coyote	17	10	11	18	17
	Dog	5	4	6	4	2
	Red fox	3	2	3	1	2
Other Livestock[3]	Coyote	8	6	7	13	14
	Dog	4	1	0	1	2
	Red fox	3	1	13	1	1

[1]In some instances assistance was provided to a single person for multiple livestock resources during multiple FYs
[2]livestock resource categories include requests for adults, juveniles, or juveniles and adults
[3]Other livestock includes alpaca, horse, llama, pig, and various species of fowl

Two forms of assistance have been provided by WS to those people requesting assistance with resolving damage or the threat of damage. Technical assistance is the provision of information, recommendations, and demonstrations on available and appropriate methods that could be conducted by the requestor without WS' direct involvement in managing or preventing the damage. WS' technical assistance activities will be discussed further in Chapter 3 of this EA. Direct operational assistance is the direct application of methods by WS. Direct operational assistance can only commence after technical assistance has been provided (see WS Directive 2.101, WS Directive 2.201) and those persons requesting assistance have been informed of their options (see WS Directive 3.101). WS' direct operational assistance activities will be discussed further in Chapter 3 of this EA. The numbers of requests for assistance are representative of the damage and threats that could be caused by coyotes, dogs and red foxes to livestock in Virginia. Many of the requests for assistance involved multiple resources and multiple species.

Need to Resolve Damage to Livestock

The conflict between humans and predators that prey on livestock dates back to the time that animals were domesticated (Shelton 2004). Predation damage to livestock can be categorized as either direct or indirect. Direct damage is damage that results from direct physical contact between livestock and a predator (e.g. death or injury due to wounds inflicted by predator). Indirect damage is incidental damage that occurs because livestock is killed, injured or pursued by a predator. Direct and indirect damage is discussed in more detail in the following sections.

Authors have noted that predation damage is unevenly distributed among livestock producers (Wagner and Pattison 1973, Balser 1974, Dorrance and Roy 1976, Gee et al. 1977, Robel et al. 1981, Knowlton et al. 1999, Shelton 2004). However, despite study it is unknown why this uneven distribution exists (Mech et al. 2000, Breck and Meier 2004). Actual losses may be substantially higher than those reported because scavengers or decay inhibits the identification of predation (O'Gara et al. 1983, Wagner 1988) or because livestock cannot be located and its cause of death identified because it has been driven or removed from the area by the predator (Nass 1977, Tigner and Larson 1977, McAdoo and Klebenow 1978, O'Gara et al. 1983, Scrivner et al. 1985, Neale et al. 1998). Coyotes, foxes and other predators are all known to display caching or food storage behavior wherein the surplus food is removed from the kill site and hidden for future consumption (Klebenow and McAdoo 1976, McDonald 1976, Windberg et al.

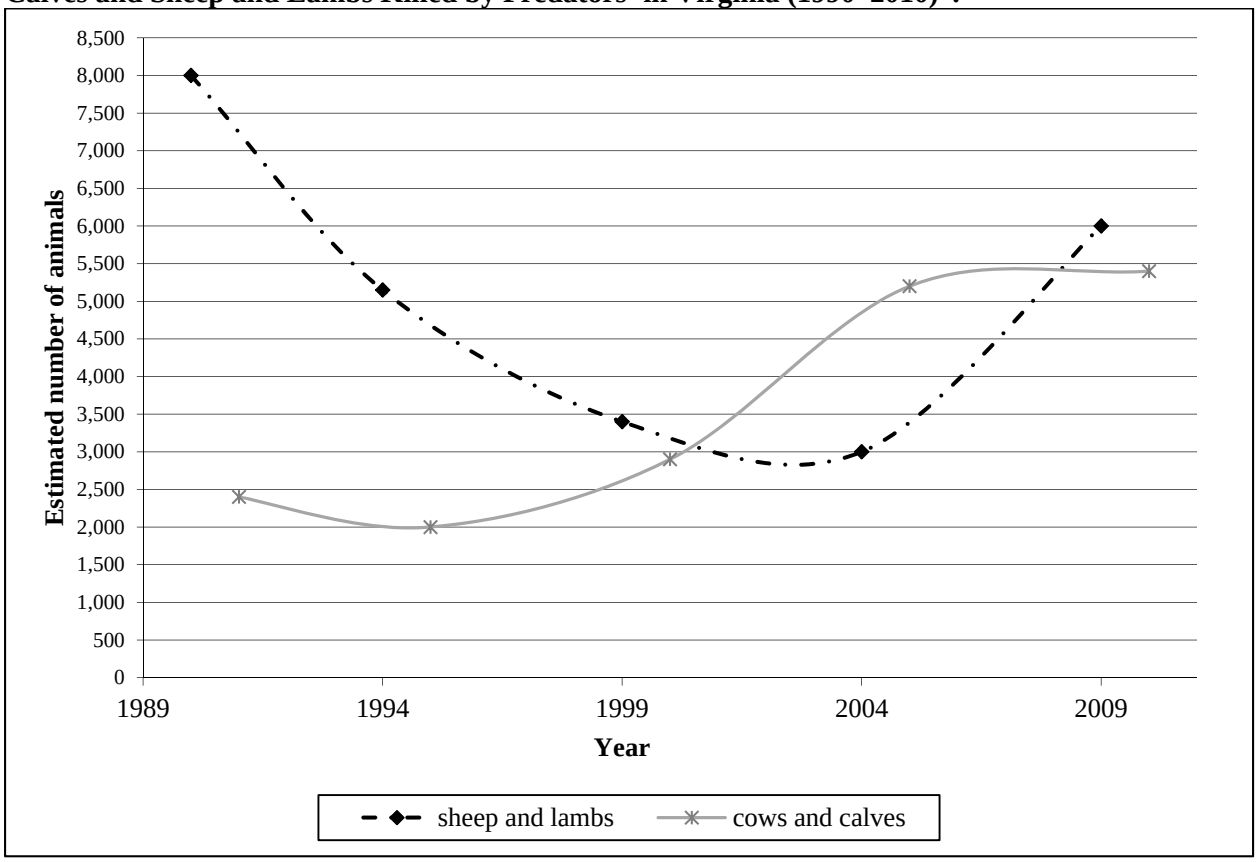
1997, Neale et al. 1998). Alternatively, missing livestock may simply be carried off and consumed in areas inaccessible (e.g. cliffs, ravines) or impenetrable (e.g. thick vegetation) to searchers. Therefore, the numbers of livestock that have been confirmed to be killed by predators may represent only the minimum numbers of livestock actually killed.

Livestock is an important industry in Virginia with approximately 8.3 million acres devoted to agricultural production in Virginia in 2012 (NASS 2014). In the same year, agricultural products sold in the Commonwealth had a market value estimated at $3.7 billion (NASS 2014). A total of 63.7% of these sales were in livestock (NASS 2014). Sales of cattle and calves in Virginia in 2012 totaled $707.9 million, while sales of sheep, goats and their products (e.g. wool, milk) totaled $11.6 million (NASS 2014). There were a total of 1.6 million cows and calves, 85,000 sheep and lambs, and 51,000 goats and kids in the Commonwealth in 2012 (NASS 2014).

Direct Predation Damage to Livestock

In the last 25 years, Virginia's livestock producers have reported predation by coyotes, bears, bobcats, dogs, eagles, foxes, and vultures as well as other unknown predators to the U.S. Department of Agriculture's National Agricultural Statistics Service (NASS) (NASS 1991, 1992, 1995, 1996, 2000, 2001, 2005, 2006, 2010, 2011). Predation of cows and calves in Virginia has increased since 1994 while predation of sheep and lambs in Virginia has increased since 2004 (Figure 1.1). It is important to note that the predation reported often occurred in situations where producers were actively implementing methods to manage predation damage (NASS 1991, 1992, 1995, 1996, 2000, 2001, 2005, 2006, NASS 2010, 2011). For example, 32% of producers surveyed used guard dogs, 15% used guard llamas and 25% used guard donkeys to protect their sheep from predators in Virginia in 2004 (NASS 2005). Additionally, losses are reported regardless of whether or not those farms are receiving or have received assistance from WS or other entities.

Figure 1.1 - National Agricultural Statistics Service (NASS)[1] Estimates of the Number of Cows and Calves and Sheep and Lambs Killed by Predators[2] in Virginia (1990–2010)[3].



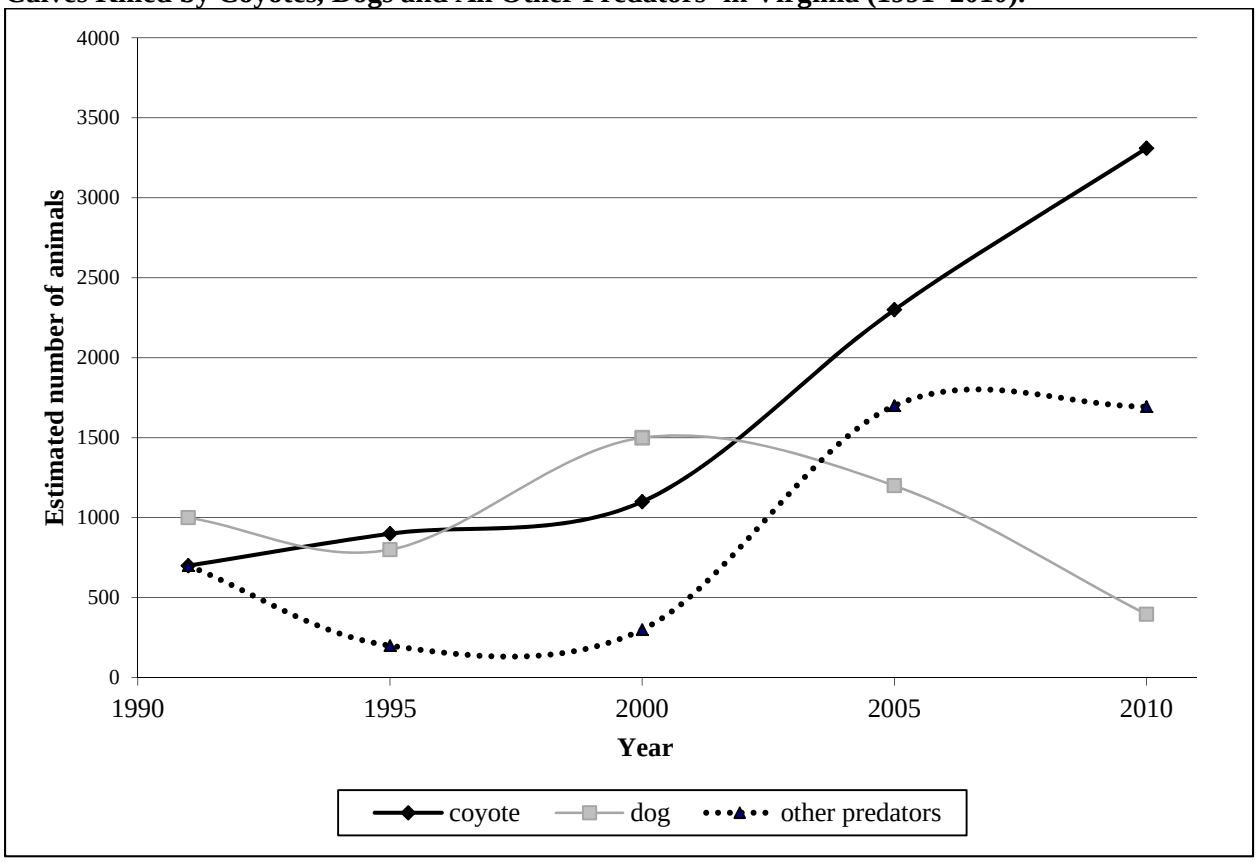
[1]Data obtained from NASS 1991, 1992, 1995, 1996, 2000, 2001, 2005, 2006, 2010, 2011
[2]Includes predation by coyotes, bears, bobcats, dogs, eagles, foxes, vultures, other and unknown predators.
[3]Predation reported often occurred in situations where producers were actively implementing methods to manage predation damage

Damage and Threats to Cattle

The total number of cows and calves lost to predators has increased in Virginia since 1996 (Figure 1.1). Losses are reported regardless of whether or not those farms are receiving or have received assistance from WS or other entities. According to NASS's latest survey estimates of cattle and calf producers in Virginia, 5,400 cows and calves valued at more than $2 million dollars were lost to predators in 2010 (NASS 2011). Calves are more likely to be lost to predators than mature cattle (NASS 2011). Of the estimated 5,400 cattle and calves lost to predators, 600 were cows (animals weighing more than 500 pounds) and 4,800 were calves (weighing less than 500 pounds) (NASS 2011). Virginia's livestock producers have reported that cows and calves have been predated by coyotes, bears, bobcats, dogs, and vultures as well as other and unknown predators (NASS 1992, 1996, 2001, 2006, 2011).

Coyote: The majority of cow and calf predation in Virginia is attributed to coyotes (NASS 1992, 1996, 2001, 2006, 2011) (Figure 1.2). An estimated 190 cows and 3,120 calves, valued at $1,181,950 dollars, were lost to coyotes in Virginia in 2010 (NASS 2011).

Figure 1.2 - National Agricultural Statistics Service (NASS)[1] Estimates of the Number of Cows and Calves Killed by Coyotes, Dogs and All Other Predators[2] in Virginia (1991–2010).



[1]Data obtained from NASS 1992, 1996, 2001, 2006, 2011.
[2]Includes predation by bear, bobcat, vultures, other and unknown predators.

Dog: Another leading cause of cow and calf predation in Virginia in 2010 was dogs (NASS 2011). Although the estimated number of cows and calves lost to dog predation has declined since 2000, an estimated 35 cows and 360 calves valued at $147,155 dollars were lost to dogs in 2010 (Figure 1.2) (NASS 2001, 2011). Historically, dogs were the leading predators of cattle in the southeast (Gee 1979). Dog predation is usually evidenced by mutilation because dogs are often indiscriminate on how and where they attack livestock (Boggess et al. 1980, Wade and Bowns 1982, Acorn and Dorrance 1990, Green and Gipson 1994). Dogs often harass livestock at length over long distances leaving widely scattered attack sites, exhausted, injured or dead livestock and fences damaged from livestock trying to escape (Boggess et al. 1980, Wade and Bowns 1982). Stress on the livestock caused by these attacks can lead to weight loss and abortion of young and injured livestock which may require euthanasia depending upon the extent of mutilation exhibited (Wade and Bowns 1982). Dogs which have a regular food source seldom consume livestock, but dogs without a regular food source tend to consume the hindquarters and viscera (Wade and Bowns 1982, Bergman et al. 2009).

Fox: In some circumstances, red fox may kill small calves (Wade and Bowns 1982). Fox predation of larger animals is evidenced by multiple bites to the throat or neck and back.

Other Predators: The number of cattle predated by bears was not estimated by NASS prior to 2010 (NASS 1992, 1996, 2001, 2006, 2011). In 2010, an estimated five cows and 259 calves, valued at $89,380 dollars were preyed upon by bears in Virginia (NASS 2011). Bears may break the neck or back of calves with blows from their paws but normally kill calves or cows with a bite to the neck or shoulders

(Wade and Bowns 1982, Acorn and Dorrance 1990). Cattle are also likely to be injured or killed when they run into or through fences or over cliffs while trying to escape bears (Wade and Bowns 1982).

Although bobcat predation on calves is rare, it can occur and has been reported in Virginia (NASS 2001). Bobcats are known to prey on white-tailed deer and other animals up to 8 times their weight (Labisky and Boulay 1998).

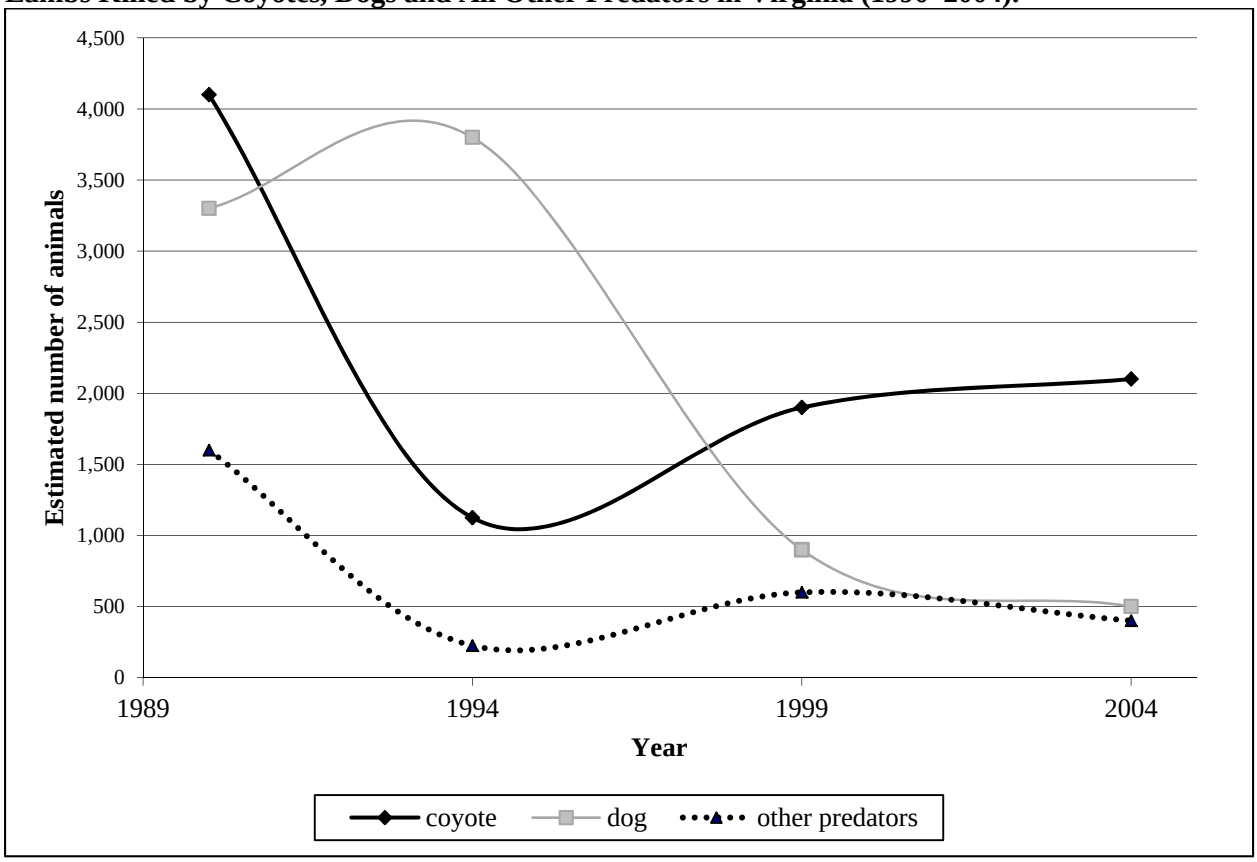
An estimated 47 cows and 619 calves valued at $219,714 dollars were lost to vultures in 2010 (NASS 2011). The number of cattle predated by vultures was not estimated by NASS prior to 2010 (NASS 1992, 1996, 2001, 2006, 2011). While both turkey vultures and black vultures have been documented harassing expectant cattle, livestock predation is generally restricted to black vultures.

Unknown: An estimated 10 cows and 38 calves were lost to 'other' predators and an estimated 312 cows and 403 calves were lost to 'unknown' predators in Virginia in 2010. Although this is a decrease in the estimated number of animals lost to 'other' and 'unknown' predators from the prior survey (NASS 2006), presumably because of the categorization of vulture and bear predation, predation by other species such as fox and eagles, although relatively rare, is possible (O'Gara and Rightmire 1987).

Damage and Threats to Sheep

In 2009, Virginia producers reported the loss of 6,000 sheep and lambs valued at $466,000 dollars to predators (NASS 2010). Lambs are more likely to be lost to predators than mature sheep (NASS 2010). Of the 6,000 sheep lost to predators, 800 were adults and 5,200 were lambs (NASS 2010). The total number of sheep and lambs lost to predators has increased in Virginia since 1994 (Figure 1.1). Losses are reported regardless of whether or not those farms are receiving or have received assistance from WS or other entities. Although loss was not attributed to specific predators in Virginia in this most recent survey of sheep and lamb producers (NASS 2010), previous surveys (NASS 2005, 2000, 1995, 1991) attributed the majority of sheep and lamb predation loss to coyotes and dogs. Virginia's livestock producers have reported that sheep and lambs have been predated by coyotes, bears, bobcats, dogs, eagles, and foxes as well as other and unknown predators (NASS 1991, 1995, 2000, 2005). Schaefer et al. (1981) found that producers correctly assessed the cause of death more than 94% of the time and that those producers who made invalid claims had little to no information on predation and identification of the predator. This has been corroborated by other authors (Klebenow and McAdoo 1976, Nass 1977). The sheep lost to predators are generally healthy (Henne 1975, Klebenow and McAdoo 1976, McAdoo and Klebenow 1978, O'Gara et al.1983). In fact, it has been suggested that healthier more active lambs attract more predator attention (Tigner and Larson 1977).

Figure 1.3 - National Agricultural Statistics Service (NASS) Estimates of the Number of Sheep and Lambs Killed by Coyotes, Dogs and All Other Predators in Virginia (1990–2004).



Coyote: The majority of sheep and lamb predation in Virginia has been attributed to coyotes (NASS 1991, 1995, 2000, 2005) (Figure 1.3). An estimated 400 sheep and 1,700 lambs, valued at $159,300 dollars, were lost to coyotes in Virginia in 2004 (NASS 2005). In a Montana study, 73% of sheep were killed by coyotes when the coyote's upper canine teeth penetrated the area below or behind the sheep's ear and the lower canine teeth penetrated the larynx on the opposite side of the sheep's throat resulting in suffocation (O'Gara et al. 1983). Small lambs are also killed by coyotes when their skulls are punctured or fractured (O'Gara et al. 1983). Sheep are not always consumed, especially on days when multiple sheep are killed (O'Gara et al. 1983).

Dog: The other leading cause of sheep and lamb predation in Virginia in 2004 was dogs (NASS 2005). Although the estimated number of sheep and lambs lost to dog predation has declined since 1994, an estimated 200 sheep and 300 lambs valued at $46,100 dollars were lost to dogs in 2004 (Figure 1.3) (NASS 1991, 1995, 2000, 2005). NASS figures for Virginia show that losses of lambs to dogs are greater than those of sheep, while a study in Ohio documented that the reverse can occur (Blair and Townsend 1983). As with cattle, dog predation on sheep is usually evidenced by mutilation because dogs are often indiscriminate on how and where they attack livestock (Boggess et al. 1980, Wade and Bowns 1982, Acorn and Dorrance 1990, Green and Gipson 1994). Because of this, sheep are often injured and have to be euthanized due to their injuries, or die as a result of injuries sustained in the predation event (Tigner and Larson 1977, Boggess et al. 1980, Wade and Bowns 1982, Acorn and Dorrance 1990). Sheep are particularly vulnerable to dog predation because they drown trying to swim to safety, or die from suffocation when they are crowded against each other after being driven into the corner of a pasture, a gully, barn or other confined space (Wade and Bowns 1982). Evidence of dog predation includes widely

scattered attack sites, exhausted, injured or dead livestock and fences damaged from livestock trying to escape (Wade and Bowns 1982). Stress on the livestock caused by these attacks can lead to weight loss and abortion of young (Wade and Bowns 1982). Dogs may or may not consume sheep depending upon the availability of other reliable food sources (Bergman et al. 2009).

Fox: Fox predation occurs to both sheep and lambs although predation of lambs is more common (Henne 1977; O'Gara et al. 1983; Witmer et al. 1993; Poole and McKillop 2002; NASS 1991, 1995, 2000, 2005). Often only small lambs are killed but under some circumstances red fox may kill large lambs and adult sheep (Wade and Bowns 1982). Fox predation is evidenced by multiple bites to the throat, neck and back. Foxes do not have the body mass and strength to immobilize larger animals well; therefore, livestock often have multiple puncture wounds. Small prey may be carried away without any evidence of predation at the kill site (Acorn and Dorrance 1990).

Other Predators: NASS reports that bear predation occurs to both sheep and lambs in Virginia (NASS 2000, 1995, 1991). Bears may break the neck or back of sheep with blows from their paws but normally kill with a bite to the neck or shoulders (Wade and Bowns 1982). Multiple kills are fairly common. As with dog predation, sheep are vulnerable to bear predation because they drown trying to swim to safety, or die from suffocation when they are crowded against each other after being driven into the corner of a pasture, a gully, barn or other confined space (Wade and Bowns 1982). Sheep are also likely to be injured or killed when they run into fences or over cliffs while trying to escape bears (Wade and Bowns 1982). Bears tend to prefer muscle to viscera but have an affinity for consuming the udders of lactating females (Wade and Bowns 1982).

Bobcats are known predators of lambs (NASS 1991, 1995, 2000, 2005). Although not regular predators of sheep, bobcats are known predators of animals up to eight times their weight (Labisky and Boulay 1998). Lambs are usually killed with a bite to the skull, the back of the neck or the throat. Bobcats usually kill larger animals such as sheep by leaping on their shoulders or back and biting their neck (Wade and Bowns 1982). Small prey may be consumed entirely in a single feeding or carried away (Wade and Bowns 1982). Larger prey may be covered in vegetation and soil and fed upon multiple times (Labisky and Boulay 1998).

Vultures are known predators of livestock including sheep and lambs in Virginia (Lowney 1999). NASS reports have never estimated the number of sheep and lambs lost to vultures (NASS 1991, 1995, 2000, 2005, 2010) and estimates of the number of cattle and calves lost to vultures was not estimated by NASS prior to 2010 (NASS 1992, 1996, 2001, 2006, 2011). However, given that vultures were identified as the second leading cause of predation of cattle in the most recent NASS cattle and calf report (NASS 2011), it is highly probable that a large percentage of sheep and lambs lost to other or unknown causes are lost to vultures. From 1990 to 2009, a total of 100 to 300 sheep and lambs were lost to other and unknown predators on an annual basis (NASS 1991, 1995, 2000, 2005).

Both bald and golden eagles can also be predators of sheep (Wade and Bowns 1982; McEneaney and Jenkins 1983; O'Gara 1983; NASS 1991, 1995, 2005). Eagle predation of lambs has been reported in Virginia (NASS 2005, 1995, 1991). Generally eagles prefer young animals and eagle predation is characterized by talon punctures and skin being turned inside out (Wade and Bowns 1982). Lambs die when talon's puncture the lungs or major blood vessels (O'Gara et al. 1983).

Unknown: Often scavengers or decay inhibits the identification of predation (O'Gara et al. 1983) or lambs and sheep cannot be found and predation is assumed (Nass 1977, Tigner and Larson 1977, McAdoo and Klebenow 1978, O'Gara et al. 1983, Scrivner et al. 1985, Neale et al. 1998). Some of these missing animals, especially small lambs, can likely be attributed to predator caching or food storage behavior wherein the surplus food (in this case the lamb) is removed from the kill site and hidden for

future consumption. Coyotes, bobcat, fox and other native predators are all known to display this behavior (Klebenow and McAdoo 1976, McDonald 1976, Windberg et al. 1997, Neale et al. 1998). Alternatively, missing animals may simply be carried off and consumed in areas inaccessible (e.g. cliffs, ravines) or impenetrable (e.g. thick vegetation) to searchers.

Damage and Threats to Goats

In 2009, producers lost 180,000 goats and kids valued at $18.7 million dollars to predators nationwide (NASS 2010). Although no figures are given for the number of goats and kids lost to predation in Virginia, NASS reported that in 2009, the same year in which the predation loss survey was conducted, there were 3.71 million goats and kids in the U.S. (NASS 2009). A loss of 180,000 goats and kids to predators would therefore represent 4.8% of the total number of goats and kids nationwide. In 2012, there were 50,831 goats and kids in Virginia (NASS 2014). If we assume an annual predation loss of 4.8%, we could estimate that 2,466 goats and kids were lost to predators in Virginia in 2012. A lack of information on the age and breed of goats lost does not allow us to assign a monetary value to this loss. Producers report that goats and kids are lost to bears, bobcats, coyotes, dogs, eagles, foxes, vultures and other animals (NASS 1991, 2000).

Damage and Threats to Other Livestock

Livestock producers in Virginia have reported losses and damage caused by coyotes, dogs and red foxes to other livestock including alpaca, donkey, horse, llama, pig, rabbit, and various species of fowl (C. Fox, USDA APHIS WS, personal communication, 2014). This damage has also been described in the literature (Boggess et al. 1978, Pearson and Caroline 1981, Wade and Bowns 1982, Berger and Rudman 1985, Acorn and Dorrance 1990, Bergman et al. 2009).

The Code of Virginia gives two definitions of the term livestock. One in § 3.2-5400 and another in § 3.2-5900. For the purposes of this document, WS will recognize § 3.2-5900, the broader of the two definitions. Section § 3.2-5900 states, “"Livestock" includes all domestic or domesticated bovine animals; equine animals; ovine animals; porcine animals; cervidae animals; capradae animals; animals of the genus Lama; ratites; fish or shellfish in aquaculture facilities, as defined in § 3.2-2600; enclosed rabbits or hares raised for human food or fiber; or any other individual animal specifically raised for food or fiber, except companion animals.

Indirect Predation Damage to Livestock

The value of livestock killed or the reduced value of livestock injured by a predator represents only a small fraction of the actual costs of predation. Indirect damage is incidental damage that occurs because livestock is killed, injured or pursued by a predator.

Damage related to predation events

Indirect damage related to predation events includes the costs associated with looking for injured or dead livestock, disposing of dead livestock, and caring for livestock injured or exhausted as a result of being pursued or attacked (Wagner 1988). It includes the costs associated with fixing fences, gates or other infrastructure compromised when livestock (usually cattle) are stampeded into it (Wagner 1988). It also includes the cost associated with having to locate and obtain replacement animals (Connolly 1992).

Livestock respond to the presence of predators by changing their behavior (Kluever et al. 2008). Behavioral responses have wide-ranging effects including changes in vigilance and foraging efficiency, diet and habitat selection, physiological health and social responses (Laundré et al. 2001, Howery and DeLiberto 2004). When livestock encounter predators, their ability to forage may decrease as their

vigilance increases (Howery and DeLiberto 2004). Kluever et al. (2008) found that mother cows whose calves were killed by predators increased vigilance and decreased foraging rates following a predation event. Vigilance rates of these mother cows were greater than ten times that of mother cows that were temporarily separated from their calves (Kluever et al. 2008). After predation events, livestock may avoid locations where predation occurred, especially if these locations are associated with pain or fear (Howery and DeLiberto 2004). This may affect livestock's ability to preferentially select high quality habitats and diets needed to meet their physiological needs (Howery and DeLiberto 2004). Additionally, locations which are deemed 'safe' may be preferentially selected for and experience habitat degradation (e.g. erosion) (Wagner 1988). Muhly et al. (2010) found that cattle increased movement rates and altered their selection of habitat following exposure to predators. Animals that consume more energy in the form of food in relation to energy expended typically gain more weight and produce more young (Osugi 1974, Sevi et al. 1999). Ramler et al. (2014) found that calves raised on farms where at least one cattle predation event had occurred in a given year were 3.5% or 22 pounds lighter on average than calves raised on farms where predation had not occurred, an economically meaningful loss.

Herds of cattle and flocks of sheep that have been the target of predation use group behavior to respond to impending predation (Howery and DeLiberto 2004). Livestock may huddle together and move in groups. This can result in cattle running through fences or sheep dying from suffocation when they are crowded against each other after being driven into the corner of a pasture, a gully, barn or other confined space. Livestock that are harassed not only expend more energy by running but also indirectly reduce their ability to gain energy because of reduced rumination time. Cows, sheep and goats are ruminants. In order to effectively digest plants, they must spend time ruminating or 'chewing their cud'. Livestock that are regularly harassed have a reduced ability to digest plants (Howery and DeLiberto 2004). Harassment may also lead to reduced reproductive performance (Howery and DeLiberto 2004). Livestock repeatedly exposed to predation events may not enter estrus or produce sperm or if they do breed may have increased risk of abortions, stillbirths, deliver prematurely or give birth to weak young (Howery and DeLiberto 2004, Lehmkuhler et al. 2007). Additionally, if young are present when predation events occur they can become separated from their mothers, dying from trampling, exposure or starvation (Tigner and Larson 1977). The regular presence of predators can also result in chronic stress which may lead to an increased susceptibility to disease (Faries and Adams 1997). Coyotes (Gondim et al. 2004) and dogs (McAllister 1999) are known carriers of *Neospora caninum*, a protozoan parasite. This parasite is a frequent cause of calf abortions (Dubey 2003). Cattle can become infected by grazing on pasture or drinking water contaminated with infected predator feces (Dubey 2003). Barling et al. (2000) found statistically significant spatial associations between the density of cattle with the virus and the abundance of coyotes and grey foxes (*Urocyon cineoargenteus*). A total of 11.5% of coyotes tested throughout Pennsylvania were positive for *Neospora caninum* (Cegelski 2008). Calf abortion caused by this parasite has been identified by a veterinarian and reported by the producer to WS in Virginia (C. Fox, USDA APHIS WS, personal communication, 2014).

Damage related to managing predation

The methods available to manage predation damage are discussed in detail in Appendix B. The implementation of these methods can have substantial costs. For example, livestock can legally be confined in the Commonwealth with a fence that is 42 inches high and consists of four strands of barbed wire (The Code of Virginia § 55-299). However, this type of fence will not exclude coyotes, dogs or red foxes. Installation of a woven wire or woven mesh fence that could exclude the majority of these predators would be a substantial financial investment. Other methods, such as guard animals, have ongoing costs associated with them (e.g. training, feed, veterinary care). The implementation of some methods may also have effects on animal performance. For example, 'penning' or confining animals at night, may lead to increased parasite infestations.

Damage related to future income

Predation can also result in reduced future income for the producer. For example, if the repayment of loans is delayed the producer may have increased interest fees (Scrivner et al. 1985) or the producer may choose to pay a premium to obtain insurance against predation losses (Connolly 1992). The loss of this potential income to the producer also has impacts on the community to which they contribute (Connolly 1992). Predation is also one of the reasons cited by producers for leaving the sheep and goat industry (Nunley 2004, Shelton 2004).

1.4 DECISIONS TO BE MADE

Based on agency relationships, MOUs, and legislative authorities, WS is the lead agency for this EA, and therefore, responsible for the scope, content, and decisions made. Management of coyotes and red foxes is the responsibility of the Virginia Department of Game and Inland Fisheries (VDGIF). Therefore, the lethal removal of coyotes and red foxes by WS to alleviate damage or reduce threats of damage as described in this EA could only occur within the parameters established by the VDGIF. Cooperation between VDGIF and WS ensures WS' actions are incorporated into population objectives established by the VDGIF. Dogs are classified as companion animals in the Commonwealth of Virginia and are managed by local law enforcement and animal control authorities. However, The Code of Virginia (§ 3.2-6552) allows WS to seize or kill "…a dog in the act of killing or injuring livestock..." or "...a dog chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock".

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

- How can WS best respond to the need to address livestock damage caused by coyotes, dogs and red foxes in Virginia?
- Do the alternatives have significant impacts meriting an Environmental Impact Statement (EIS)?

1.5 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

Actions Analyzed

This EA evaluates the need to manage damage or threats of damage to livestock associated with coyotes, dogs and red foxes on federal, Commonwealth, tribal, municipal, and private land within the Commonwealth of Virginia, wherever such management is requested by those seeking assistance. This EA discusses the issues associated with conducting damage management activities to meet the need for action and evaluates different alternatives to meet that need while addressing those issues.

The methods available to manage damage and threats to livestock associated with coyotes, dogs and red foxes are discussed in Appendix B. The alternatives and Appendix B also discuss how methods would be employed to manage these damages and threats. Therefore, the actions evaluated in this EA are the use or recommendation of those methods available under the alternatives and the employment or recommendation of those methods by WS to manage or prevent damage and threats to livestock associated with coyotes, dogs and red foxes from occurring when requested and permitted.

Native American Lands

The WS program in Virginia would only conduct damage management activities on Native American lands when requested by a Native American Tribe. Activities would only be conducted after a Memorandum of Understanding (MOU) or cooperative service agreement had been signed between WS and the Tribe requesting assistance. Therefore, the Tribe would determine when WS' assistance was required and what activities would be allowed. Because Tribal officials would be responsible for requesting assistance from WS and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would be anticipated. Those methods available to alleviate damage and threats to livestock associated with coyotes, dogs and red foxes on federal, Commonwealth, county, municipal, and private properties under the alternatives analyzed in this EA would be available for use to alleviate damage on Tribal properties when the use of those methods had been approved for use by the Tribe requesting WS' assistance. Therefore, the activities and methods addressed under the alternatives would include those activities that could be employed on Native American lands, when requested and agreed upon between the Tribe and WS.

Federal, Commonwealth, County, City, and Private Lands

Under two of the alternatives analyzed in detail, WS could continue to provide assistance on federal, state, county, municipal, and private land in Virginia when a request was received for such services by the appropriate resource owner or manager. In those cases where a federal agency requests WS' assistance with managing damage to livestock associated with coyotes, dogs or red foxes, the requesting agency would be responsible for analyzing those activities in accordance with the NEPA. However, this EA could cover such actions if the requesting federal agency determined the analyses and scope of this EA were appropriate for those actions and the requesting federal agency adopted this EA through their own decision based on the analyses in this EA. Therefore, actions taken on federal lands have been analyzed in the scope of this EA.

Period for which this EA is Valid

If the analyses in this EA indicates an Environmental Impact Statement (EIS) is not warranted, this EA would remain valid until WS determines that new needs for action, changed conditions, new issues, or new alternatives having different potential environmental impacts must be analyzed. At that time, this analysis and document would be reviewed and, if appropriate, supplemented pursuant to the NEPA. Review of the EA would be conducted to ensure that activities implemented under the selected alternative occur within the parameters evaluated in the EA. If the alternative analyzing no involvement in damage management activities by WS were selected, no additional analyses by WS would occur based on the lack of involvement by WS. The monitoring of activities by WS would ensure the EA remained appropriate to the scope of activities conducted by WS under the selected alternative.

Site Specificity

This EA analyzes the potential impacts of alternative approaches to managing damage and threats to livestock associated with coyotes, dogs and red foxes that could be conducted on private and public lands in Virginia where WS and the appropriate entities have entered into an agreement through the signing of a MOU, cooperative service agreement (CSA), or other comparable document. WS would only conduct damage management activities when requested by the appropriate resource owner or manager. This EA also addresses the potential impacts of conducting damage management activities in areas where additional MOUs, CSAs or other comparable documents may be signed in the future. Because the need for action is to reduce damage and because the goals and directives of WS are to provide services when requested, within the constraints of available funding and workforce, it is conceivable that additional

efforts could occur. Thus, this EA anticipates those additional efforts and analyzes the impacts of such efforts as part of the alternatives.

Coyotes, dogs and red foxes can be found across the Commonwealth throughout the year. Therefore, damage or threats of damage to livestock associated with coyotes, dogs and red foxes could occur wherever coyotes, dogs or red foxes and livestock occur. Planning for the management of damage and threats to livestock associated with coyotes, dogs and red foxes must be viewed as being conceptually similar to the actions of other entities whose missions are to stop or prevent adverse consequences from anticipated future events, such as natural disasters, for which the actual site and locations where they would occur are unknown but could be anywhere in a defined geographic area. Examples of such agencies and programs include fire departments, police departments, emergency clean-up organizations, and insurance companies. Some of the sites where damage could occur can be predicted; however, all specific locations or times where such damage would occur in any given year cannot be predicted. The threshold triggering an entity to request assistance from WS to manage damage and threats to livestock associated with coyotes, dogs and red foxes is often unique to the individual; therefore, predicting where and when such a request for assistance will be received by WS would be difficult. This EA emphasizes major issues as those issues relate to specific areas whenever possible; however, many issues apply wherever damage or the threat of damage could occur and those issues are treated as such in this EA.

Chapter 2 of this EA identifies and discusses issues relating to the management of damage and threats to livestock associated with coyotes, dogs and red foxes in Virginia. The standard WS Decision Model (Slate et al. 1992) would be the site-specific procedure for individual actions conducted by WS (see Chapter 3 for a description of the Decision Model and its application). Decisions made using the model would occur in accordance with WS' directives and Standard Operating Procedures (SOPs) as described in Chapter 3 of this EA, as well as relevant laws and regulations.

The analyses in this EA are intended to apply to any action that may occur in any locale and at any time within Virginia. In this way, WS believes it meets the intent of the NEPA with regard to site-specific analysis and that this is the only practical way for WS to comply with the NEPA and still be able to address damage and threats to livestock associated with coyotes, dogs and red foxes.

Summary of Public Involvement

Issues related to the management of damage and threats to livestock associated with coyotes, dogs and red foxes and the alternatives to address those issues were initially developed by WS. Issues were defined and preliminary alternatives were identified through the scoping process. As part of this process, and as required by the Council on Environmental Quality (CEQ) and APHIS' NEPA implementing regulations, this document will be noticed to the public for review and comment. This EA will be noticed to the public through legal notices published in local print media, through the APHIS stakeholder registry, and by posting the EA on the APHIS website at http://www.aphis.usda.gov/wildlifedamage/nepa.

WS will make the EA available for a minimum of 30 days comment period for the public and interested parties to provide new issues, concerns, and/or alternatives. Through the public involvement process, WS will clearly communicate to the public and interested parties the analyses of potential environmental impacts on the quality of the human environment. New issues or alternatives identified after publication of notices announcing the availability of the EA will be fully considered to determine whether the EA should be revisited and, if appropriate, revised prior to issuance of a Decision.

1.6 RELATIONSHIP OF THIS DOCUMENT TO OTHER ENVIRONMENTAL DOCUMENTS

Final Environmental Assessment: Proposal to Permit Take as Provided Under the Bald and Golden Eagle Protection Act:

Developed by the USFWS, this EA evaluated the issues and alternatives associated with the promulgation of new regulations to authorize the "take" of bald eagles and golden eagles as defined under the Bald and Golden Eagle Protection Act. The preferred alternative in the EA evaluated the authorization of disturbance take of eagles, the removal of eagle nests where necessary to reduce threats to human safety, and the issuance of permits authorizing the lethal removal of eagles in limited circumstances, including authorizing take that is associated with, but is not the purpose of, an action (USFWS 2009). A Decision and Finding of No Significant Impact (FONSI) was made for the preferred alternative in the EA. The selected alternative in the EA established new permit regulations for the "take" of eagles (see 50 CFR 22.26) and a provision to authorize the removal of eagle nests (see 50 CFR 22.27). The USFWS published a Final Rule on September 11, 2009 (74 FR 46836-46879).

WS' Environmental Assessments:

WS had previously developed an EA that analyzed the need for action to manage damage and threats to livestock (USDA 2002a, USDA 2007). This EA identified the issues associated with managing damage to livestock associated with coyotes, dogs and red foxes in the Commonwealth and analyzed alternative approaches to meet the specific need identified in the EA while addressing the identified issues. Since activities conducted under the previous EA will be re-evaluated under this EA to address the new need for action and the associated affected environment, the previous EA that addressed damage and threats to livestock associated with coyotes, dogs and red foxes will be superseded by this analysis and the outcome of the Decision issued based on the analyses in this EA.

1.7 AUTHORITY OF FEDERAL AND STATE AGENCIES

The authorities of WS and other agencies as those authorities relate to conducting activities to alleviate animal damage are discussed by agency below:

Wildlife Services (WS):

The primary statutory authorities for the WS program are the Act of March 2, 1931 (46 Stat. 1468; 7 USC 426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 426c). 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 managing animal damage and threats.

United States Fish and Wildlife Service (USFWS):

The USFWS is the primary federal agency responsible for conserving, protecting, and enhancing the nation's fish and wildlife resources and their habitat. The USFWS has specific responsibilities for the protection of migratory birds, threatened and endangered species, inter-jurisdictional fish, and certain marine mammals, as well as for lands and waters managed by the agency in the National Wildlife Refuge System. The USFWS has statutory authority for enforcing the Fish and Wildlife Improvement Act of 1978 (16 USC 7.12), the Fish and Wildlife Act of 1956 (16 USC 742 a-j), and the Migratory Bird Treaty Act (16 USC 703-711).

United States Environmental Protection Agency (EPA):

The U.S. Environmental Protection Agency (EPA) is responsible for implementing and enforcing the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which regulates the registration and use of pesticides, including repellents and pesticides available for use to manage damage to livestock associated with coyotes, dogs and red foxes.

United States Food and Drug Administration (FDA):

The U.S. Food and Drug Administration (FDA) is responsible for protecting the public health by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, our nation's food supply, cosmetics, and products that emit radiation. The FDA is also responsible for advancing the public health by helping to speed innovations that make medicines and foods more effective, safer, and more affordable; and helping the public get the accurate, science-based information they need to use medicines and foods to improve their health.

Virginia Department of Game and Inland Fisheries (VDGIF):

The VDGIF, under the direction of the Governor-appointed Board of Directors, is specifically charged by the General Assembly with the management of the Commonwealth's wildlife resources. Although many legal mandates of the Board and the Department are expressed throughout the Code of Virginia, the primary statutory authorities include wildlife management responsibilities (VAC§§29.1-103), public education charges (VAC§§29.1-109), law enforcement authorities (VAC§§29.1-109), and regulatory powers (VAC§§29.1-501). The mission of the VDGIF is:

- To manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth;
- To provide opportunity for all to enjoy wildlife, inland fish, boating and related outdoor recreation and to work diligently to safeguard the rights of the people to hunt, fish and harvest game as provided for in the Constitution of Virginia;
- To promote safety for persons and property in connection with boating, hunting and fishing;
- To provide educational outreach programs and materials that foster an awareness of and appreciation for Virginia's fish and wildlife resources, their habitats, and hunting, fishing, and boating opportunities.

The VDGIF is responsible for classifying mammals as game animals (e.g. red fox, Title 29.1, Chapter 5, section 516) or nuisance species (e.g. coyote, Title 29.1, Chapter 5, section 100) and establishing and enforcing hunting and trapping seasons and licensing fur dealers (Title 29.1, Chapter 5, sections 501, 506, 507, 508, 511, 512, 513, 516, 517, 530). Additionally, the Board of Directors is responsible for the classification and protection of endangered and threatened species (Title 29.1, Chapter 5, Sections 563, 564, 566, 568).

VDGIF has a MOU with WS to facilitate the planning, coordination, and implementation of policies developed (1) to prevent or minimize damage caused by wildlife to public and private resources, including threatened and endangered species, agriculture, property, and natural resources; (2) to address public health and safety issues associated with wildlife damage and wildlife diseases; (3) to facilitate a regular exchange of information; and (4) to provide a framework for procedures and authorizations required to conduct wildlife damage management activities in the Commonwealth of Virginia.

Virginia Department of Agriculture and Consumer Services (VDACS):

The Commissioner of Agriculture and Consumer Services has the authority to enter into agreements with the federal government, local and state agencies or other persons for the control of coyotes that pose a threat to agricultural animals (Title 3.2, Chapter 59, Section 5904). Under Title 3.2, Chapter 1, Section 102A, the Commissioner of Agriculture and Consumer Services is charged with regulating pesticides. The VDACS has the authority to classify restricted pesticides (Title 3.2, Chapter 39, Section 3904), certify and register pesticide applicators (Title 3.2, Chapter 39, Section 3906), license pesticide dealers, businesses and consultants (Title 3.2, Chapter 39, Section 3906), and conduct investigations and enforce these measures (Title 3.2, Chapter 39, Section 3906). Chapter 39 under Title 3.2 of the Code of Virginia is known as the Virginia Pesticide Control Act.

VDACS has a MOU with WS which establishes a cooperative relationship between WS and VDACS, outlines responsibilities, and sets forth annual objectives and goals of each agency for resolving wildlife conflicts in Virginia.

1.8 COMPLIANCE WITH LAWS AND STATUTES

Several laws or statutes authorize, regulate, or otherwise would affect WS' activities. WS would comply with all applicable federal, Commonwealth, and local laws and regulations in accordance with WS Directive 2.210. Those laws and regulations relevant to managing damage in the Commonwealth are addressed below:

National Environmental Policy Act (NEPA) (42 USC 4321 et seq.), as amended:

All federal actions are subject to the NEPA (Public Law 9-190, 42 USC 4321 et seq.). WS follows CEQ regulations implementing the NEPA (40 CFR 1500 et seq.). In addition, WS follows the USDA (7 CFR 1b), and APHIS Implementing Guidelines (7 CFR 372) as part of the decision-making process. Those laws, regulations, and guidelines generally outline five broad types of activities to be accomplished as part of any project: public involvement, analysis, documentation, implementation, and monitoring. The NEPA also sets forth the requirement that all major federal actions be evaluated in terms of their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts. Federal activities affecting the physical and biological environment are regulated in part by the CEQ through regulations in 40 CFR 1500-1508. In accordance with the CEQ and USDA regulations, APHIS guidelines concerning the implementation of the NEPA, as published in the Federal Register (44 CFR 50381-50384) provide guidance to WS regarding the NEPA process.

Pursuant to the NEPA and the CEQ regulations, this EA documents the analyses of potential federal actions, informs decision-makers and the public of reasonable alternatives capable of avoiding or minimizing significant effects, and serves as a decision-aiding mechanism to ensure that the policies and goals of the NEPA are infused into federal agency actions. This EA was prepared by integrating as many of the natural and social sciences as warranted, based on the potential effects of the alternatives. The direct, indirect, and cumulative impacts of the proposed action are analyzed.

Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703-711; 40 Stat. 755), as amended:

The Migratory Bird Treaty Act (MBTA) makes it unlawful to, "to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase"

some migratory bird species, or their parts, nests, or eggs (16 USC 703-711). A list of bird species protected under the MBTA can be found in 50 CFR 10.13. All actions conducted in this EA comply with the regulations of the MBTA, as amended.

Bald and Golden Eagle Protection Act (16 USC 668-668c), as amended:

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

Under the Bald and Golden Eagle Protection Act (16 USC 668-668c), the take of bald eagles is prohibited without a permit from the USFWS. Under the Act, the definition of "take" includes actions that "*pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb*" eagles. The regulations authorize the United States Fish and Wildlife Service to issue permits for the take of bald eagles and golden eagles on a limited basis (see 74 FR 46836-46837, 50 CFR 22.26, 50 CFR 22.27). As necessary, WS would apply for the appropriate permits as required by the Bald and Golden Eagle Protection Act.

Endangered Species Act (ESA) (16 USC 1531-1544):

The Endangered Species Act (ESA) recognizes that our natural heritage is of *"esthetic, ecological, educational, recreational, and scientific value to our Nation and its people*." The purpose of the Act is to protect and recover species that are in danger of becoming extinct. It is administered by the USFWS and the Department of National Marine Fisheries Service (NMFS). The USFWS has primary responsibility for terrestrial and freshwater species while the NMFS is primarily responsible for marine organisms. Under the ESA, species may be listed as endangered or threatened. Endangered is defined as a species that is in danger of becoming extinct throughout all or a significant portion of its range while threatened is defined as a species likely to become endangered in the foreseeable future. Under the ESA, *"all federal departments and agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act"* (Sec.2(c)). Additionally, the Act requires that, *"each Federal agency shall in consultation with and with the assistance of the Secretary, insure 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 or result in the destruction or adverse modification of habitat of such species…..each agency will use the best scientific and commercial data available"* (Sec.7 (a) (2)). WS consults with the USFWS or the NMFS to ensure that the agencies actions, including the actions proposed in this EA, are not likely to jeopardize the existence of endangered or threatened species or their habitat.

National Historic Preservation Act (NHPA) (16 USC 470 et seq.), as amended:

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment on such undertakings if an agency determines that the agency's actions are "*undertakings*". Undertakings are defined in Sec. 800.16(y) as a *"project, activity, or program funded in whole or part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a federal agency; those carried out with federal financial assistance; and those requiring a federal permit, license or approval"*. If the undertaking is a type of activity that does not have the potential to cause effects on historic properties, assuming such historic properties were present, the agency official has no further obligations under Section 106. None of the methods described in this EA that would be available for use under the alternatives cause major ground disturbance, any physical destruction or damage to property, any alterations of property, wildlife habitat, or landscapes, nor involves the sale, lease, or transfer of ownership of any property. In general, such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas in which they were used that could result in effects on the character or use of historic properties. Therefore, the methods that could be used by WS under the relevant alternatives are not generally the types of activities that would have the potential to affect historic properties. If an individual activity with the potential to affect historic resources were planned under an alternative selected because of a decision on this EA, the site-specific consultation as required by Section 106 of the NHPA would be conducted, as necessary.

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

Federal Actions to Address Environmental Justice in Minority Populations 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 minorities and low-income persons or populations. APHIS implements Executive Order 12898 principally through its compliance with the NEPA. All WS' activities are evaluated for their impact on the human environment and compliance with Executive Order 12898. WS would only use or recommend legal, effective, and environmentally safe methods, tools, and approaches. It is not anticipated that the proposed action would result in any adverse or disproportionate environmental impacts to minorities and persons or populations of low income.

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

Children may suffer disproportionately from environmental health and safety risks because their physical and mental systems are still developing. Each federal agency must therefore, *"make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children"* and *"ensure that its policies, programs, activities and standards address disproportionate risks to children"*. WS would only employ and/or recommend legally available and approved methods under the alternatives where it is highly unlikely that children would be adversely affected. For these reasons, WS concludes that it would not create an environmental health or safety risk to children from implementing this proposed action.

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.):

The Native American Graves Protection and Repatriation Act (NAGPRA) establishes procedures for federal agencies when Native American "*cultural items*" are inadvertently discovered on federal or tribal lands. Cultural items may include human remains, funerary objects, sacred objects, and objects of cultural patrimony. In part, the NAGPRA requires federal agencies making such discoveries to notify the Secretary of the Department that manages the federal lands or the tribal leaders on tribal lands on which the discovery was made. Additionally, once a discovery is made, work must be stopped and reasonable efforts must be made to protect the item.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 USC 136 et seq.):

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires the registration, classification, and regulation of all pesticides used in the United States. The EPA is responsible for implementing and enforcing the FIFRA. All chemical methods described in Appendix B, are registered with and regulated by the EPA and used or recommended by WS in compliance with labeling procedures and requirements.

Coastal Zone Management Act of 1972, as amended (16 USC 1451-1464, Chapter 33):

The Coastal Zone Management Act established a voluntary national program within the Department of Commerce to encourage coastal states to develop and implement coastal zone management plans. Funds were authorized for cost-sharing grants to states to develop their programs. Subsequent to federal approval of their plans, grants would be awarded for implementation purposes. In order to be eligible for federal approval, each state's plan was required to define boundaries of the coastal zone, identify uses of the area to be regulated by the state, determine the mechanism (criteria, standards or regulations) for controlling such uses, and develop broad guidelines for priorities of uses within the coastal zone. In addition, this law established a system of criteria and standards for requiring that federal actions be conducted in a manner consistent with the federally approved plan. The standard for determining consistency varied depending on whether the federal action involved a permit, license, financial assistance, or a federally authorized activity. As appropriate, a consistency determination would be conducted by WS to assure management actions would be consistent with the state's Coastal Zone Management Program.

Authority of the Commissioner; coyotes (Code of Virginia § 3.2-5904):

"The Commissioner (of Agriculture and Consumer Services) *may enter into agreements with local, state and federal agencies, or other persons for the control of coyotes that pose a danger to agricultural animals."*

Dogs killing, injuring or chasing livestock or poultry (Code of Virginia § 3.2-6552):

This section of the Code states that, *"It shall be the duty of any animal control officer or other officer who may find a dog in the act of killing or injuring livestock or poultry to seize or kill such dog forthwith whether such dog bears a tag or not. Any person finding a dog committing any of the depredations mentioned in this section shall have the right to kill such dog on sight as shall any owner of livestock or his agent finding a dog chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock."*

Hybrid canines killing, injuring or chasing livestock (Code of Virginia § 3.2-6583):

"It shall be the duty of any animal control officer or other officer who may find a hybrid canine in the act of killing or injuring livestock or poultry to kill such hybrid canine forthwith, whether such hybrid canine bears a tag or not. Any person finding a hybrid canine committing any of the depredations mentioned in this section may kill such hybrid canine on sight as may any owner of livestock or his agent finding a hybrid canine chasing livestock on land lawfully utilized by the livestock when the circumstances show that such chasing is harmful to the livestock."

In this chapter, *"Hybrid canines"* are defined as, *"any animal that is or can be demonstrated to be a hybrid of the domestic dog and any other species of the Canidae family; that at any time has been permitted, registered, licensed, or advertised as such; or that at any time has been described, represented, or reported as such by its owner to a licensed veterinarian, law-enforcement officer, animal control officer, humane investigator, official of the Department of Health, or State Veterinarian's representative"* (§ 3.2-6581).

Bounties for Coyotes (Code of Virginia § 15.2-926.1):

This section of the Code states that, *"Any locality may by ordinance permit the killing of coyotes within its boundaries at any time and may pay, out of any available funds, a bounty for each coyote killed within its boundaries. The ordinance may prescribe the conditions to be met and the evidence to be submitted before any such payment is made, as well as the amount of the bounty to be paid."*

Open Season on Nuisance Species (Code of Virginia § 29.1-511):

"There shall be a continuous open season for killing nuisance species…". In this chapter, *"coyotes"* are included in the definition of *"nuisance species"* (§ 29.1-100).

Game Animals (Code of Virginia § 29.1-516):

"Foxes may be killed at any time by the owner or tenant of any land when such animals are doing damage to domestic stock or fowl."

Trapping and shooting of fur-bearing animals during closed season (Code of Virginia § 29.1-517):

"A landowner may trap or shoot fur-bearing animals upon his own land during closed season when these animals are causing damage to crops or property, or are posing a threat to human health or safety, or are otherwise causing a nuisance." In this chapter, "*fox*" are included in the definition of "*fur-bearing animals*" (§ 29.1-100).

Open and closed season for trapping, bag limits, etc. (Code of Virginia § 29.1-530):

"There shall be a continuous open season for trapping nuisance species…". In this chapter, *"coyotes"* are included in the definition of *"nuisance species"* (§ 29.1-100).

Rules and Regulations for Enforcement of the Virginia Pesticide Law (The Virginia Administrative Code (2 VAC-5 -670, 680, 685)):

Chapter 39 under Title 3.2 of the Code of Virginia is known as the Virginia Pesticide Control Act. Chapters 670, 680 and 685 of Title 2, Agency 5 of the Virginia Administrative code contain the implementing regulations of the Act. These regulations include the classification and registration of pesticides, the handling, storage and application of pesticides, as well as the certification and registration of sellers and users.

Nuisance Species Designated (The Virginia Administrative Code (4 VAC-15-20-160)):

In this section of the Code, the VDGIF designates, "coyote (*Canis latrans*)", addressed in this EA as a nuisance species.

Possession, Transportation, and Release of Wildlife by Authorized Persons (4 VAC-15-30-50)

Under the Virginia Administrative Code (VAC), "*...U.S. government agencies' employees whose responsibility includes fisheries and wildlife management...will be deemed to be permitted...to capture, temporarily hold or possess, transport, release, and when necessary humanely euthanize wildlife, provided that the methods of and documentation for the capture, possession, transport, release and euthanasia shall be in accordance with board policy.*

Possession, Importation, Sale, etc., of Wild Animals (The Virginia Administrative Code (4 VAC 15-30-10):

"*…it shall be unlawful to take, possess, import, cause to be imported, export, cause to be exported, buy, sell, offer for sale, or liberate within the Commonwealth any wild animal…*"

Permit Required to Import, Liberate or Possess Predatory or Undesirable Animals or Birds (The Virginia Administrative Code (4 VAC 15-30-20)):

Wolves, coyotes or other animals, *"…classed as predatory or undesirable, may not be imported into the Commonwealth or liberated therein, or possessed therein, except under a special permit…"*.

Possession, Transportation and Release of Wildlife by Authorized Persons (The Virginia Administrative Code (4 VAC 15-30-50)):

Title 4, Agency 15, Chapter 30, Section 50(a) states *"…U.S. government agencies' employees whose responsibility includes fisheries and wildlife management…..in the performance of their official duties related to public health concerns of problem wildlife removal…will be permitted pursuant to this section to capture, temporarily hold or possess, transport, release, and when necessary humanely euthanize wildlife.."* Under section 50(d) these persons in their official duties may also, "*temporarily possess, transport, and dispose of carcasses of wild animals killed by vehicles, except for state or federal threatened and endangered species, and federally protected migratory bird species*".

Poisoning of Wild Birds and Wild Animals Prohibited; certain control programs excepted (The Virginia Administrative Code (4 VAC-15-40-50)):

"It shall be unlawful to put out poison at any time for the purpose of killing any wild birds and wild animals, provided that rats and mice may be poisoned on one's own property. The provisions of this section shall not apply to the Commissioner of Agriculture and Consumer Services, the United States Department of Agriculture, or their representatives or cooperators, and those being assisted in a control program authorized by those agencies."

Killing by Landowner (The Virginia Administrative Code (4 VAC-15-110-80):

"A landowner may kill or have killed foxes at any time on his own land."

CHAPTER 2: AFFECTED ENVIRONMENT AND ISSUES

Chapter 2 contains a discussion of the issues, including issues that will receive detailed environmental impact analysis in Chapter 4 (Environmental Consequences), issues that have driven the development of standard operating procedures (SOPs), and issues that were identified but will not be considered in detail, with rationale. Pertinent portions of the affected environment will be included in this chapter during the discussion of issues used to develop the SOPs. Additional descriptions of affected environments will be incorporated into the discussion of the environmental effects in Chapter 4.

2.1 AFFECTED ENVIRONMENT

Coyotes, dogs and red foxes can be found across the Commonwealth throughout the year. Therefore, damage or threats of damage to livestock associated with coyotes, dogs and red foxes could occur wherever coyotes, dogs or red foxes and livestock occur as would requests for assistance to manage damage or threats of damage. Assistance would only be provided by WS when requested by a landowner or manager and WS would only provide direct operational assistance on properties where a MOU, CSA, or other comparable document had been signed between WS and the cooperating entity.

Upon receiving a request for assistance, the proposed action alternative, or those actions described in the other alternatives could be conducted on private, federal, Commonwealth, tribal, and municipal lands in Virginia to reduce damage and threats to livestock associated with coyotes, dogs and red foxes. The analyses in this EA are intended to apply to actions taken under the selected alternative that could occur in any locale and at any time within the analysis area. This EA analyzes the potential impacts of coyote, dog and red fox damage management and addresses activities in Virginia that are currently being conducted under a MOU, CSA, or other comparable document with WS. This EA also addresses the potential impacts of coyote, dog and red fox damage management in the Commonwealth where additional agreements may be signed in the future.

Environmental Status Quo

As defined by the NEPA implementing regulations, the *"human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment"* (40 CFR 1508.14). Therefore, when a federal agency analyzes its potential impacts on the "*human environment*," it is reasonable for that agency to compare not only the effects of the proposed federal action, but also the potential impacts that could or would occur from a non-federal entity conducting the action in the absence of the federal action. This concept is applicable to situations

involving federal assistance in managing damage associated with resident wildlife species managed by the state natural resources agency, invasive species, or unprotected species.

Most wildlife species are protected under Commonwealth and/or federal law. To address damage associated with these species, a permit must be obtained from the appropriate Commonwealth agency. However, in some situations, species can be managed without the need for a permit. In Virginia, coyotes are classified as nuisance species (§ 29.1-100) and can therefore be lethally removed throughout the year (§29.1-511, §29.1-530). Red foxes are classified both as a game animal (§ 29.1-516) and as a fur-bearing animal (§ 29.1-100). Red foxes can be lethally removed when they are causing damage or a nuisance or at any time by a landowner or their designee (§ 29.1-516, § 29.1-517, 4 VAC 15-110-80). Additionally, red foxes can be legally harvested during hunting and trapping seasons. However, method restrictions apply in all instances (e.g. firearms restrictions, trapping restrictions, pesticide regulations).

Under Commonwealth law, dogs or hybrid canines, "*in the act of killing or injuring livestock"* or "*chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock"*, can be seized or lethally removed (§ 3.2-6552, § 3.2-6583). Additionally, the owner of dogs or hybrid canines believed to be killing, injuring, or chasing livestock can be brought before a general district court. If it appears that the dog or hybrid canine is causing damage the court "*shall order that the dog be: (i) killed immediately… or (ii) removed to another state that does not border on the Commonwealth and prohibited from returning to the Commonwealth"* (§ 3.2-6552, § 3.2-6583). "*Hybrid canines*" are defined as, "any animal that is or can be demonstrated to be a hybrid of the domestic dog and any other species of the Canidae family…" (§ 3.2-6581).

When a non-federal entity (e.g., agricultural producers, individuals, or any other non-federal entity) takes an action involving coyotes, dogs or red foxes, the action is not subject to compliance with the NEPA due to the lack of federal involvement[4] in the action. Under such circumstances, the environmental baseline or status quo must be viewed as an environment that includes those resources as they are managed or impacted by non-federal entities in the absence of the federal action being proposed.

Therefore, in those situations in which a non-federal entity has decided that a management action directed towards coyotes, dogs or red foxes should occur and even the particular methods that should be used, WS' involvement in the action would not affect the environmental status quo because the entity could take the action in the absence of WS' involvement. Because A) lethal coyote removal could occur at any time without the need for a permit, B) dogs or hybrid canines could be seized or lethally removed when killing, injuring or chasing livestock, and C) lethal red fox removal could occur when they are causing damage or a nuisance, or at any time by a landowner or their designee, an entity could take action in the absence of WS' involvement. WS' involvement would not change the environmental status quo if the requestor had conducted the action in the absence of WS' involvement in the action.

2.2 ISSUES ADDRESSED IN THE ANALYSIS OF THE ALTERNATIVES

Issues are concerns of the public and/or professional community raised regarding potential adverse effects that might occur from a proposed action. Such issues must be considered in the NEPA decision-making process. Issues related to managing damage associated with coyotes, dogs and red foxes in Virginia were developed by WS.

The issues as those issues relate to the possible implementation of the alternatives, including the proposed action alternative, are discussed in Chapter 4. The issues analyzed in detail are the following:

[4] If a federal permit were required to conduct damage management activities, the issuing federal agency would be responsible for compliance with the NEPA for issuing the permit.

Issue 1 - Effects of Damage Management Activities on Coyote and Red Fox Populations

A common issue when addressing damage caused by wildlife are the potential impacts of management actions on the populations of target species. Methods available to resolve damage or threats of damage can be categorized as lethal and non-lethal. Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive or unavailable to the species (target species) causing the damage, thereby reducing the presence of those species in the immediate area. Lethal methods remove individuals of target species causing the damage, thereby reducing the presence of those species in the area and reducing the local population. The number of target species lethally removed under the alternatives is dependent upon the magnitude of the damage occurring, the level of damage acceptable to individual persons experiencing the damage, the numbers of individual coyotes or red foxes involved, and the efficacy of methods employed. Under certain alternatives, both non-lethal and lethal methods could be recommended, as governed by federal, state, and local laws and regulations.

The analysis for the magnitude of impact on the populations of coyotes and red foxes is based on a measure of the number of individuals from each species removed in relation to that species' abundance. Magnitude may be determined either quantitatively or qualitatively. Quantitative determinations are based on population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations are based on population trends and harvest trend data, when available.

The analysis to determine the magnitude of impacts on the populations of those species addressed in this EA from the use of lethal methods would be based on a measure of the number of individuals lethally removed in relation to that species' abundance. Lethal removal would be monitored by comparing the number of coyotes or red foxes lethally removed with overall populations or trends. Lethal methods would only be used by WS at the request of those persons seeking assistance. Lethal removal of coyotes can occur throughout the year. Lethal removal of foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee, or during hunting and trapping seasons. Any activities conducted by WS under the alternatives addressed would occur along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, mortality from regulated harvest, and human-induced alterations of wildlife habitat.

Information on coyote and red fox populations and trends are derived from several sources including harvest data, fur dealer reports and bow hunter surveys. Further information on those sources of information is provided below.

Annual Hunter Harvest Estimates

Hunting seasons are established and enforced by the VDGIF. The VDGIF conducts periodic surveys of licensed hunters to estimate the number of animals harvested (e.g., see Jagnow et al. 2009). Although lethal removal of coyotes and red foxes can occur throughout the year by a landowner without need for a license, many coyotes and red foxes are lethally removed by individuals with licenses, and therefore reported during the survey. Survey participants are asked not to report animals trapped during annual established trapping seasons.

Annual Fur Dealer Reports

The VDGIF establishes and enforces trapping seasons and licenses fur dealers (i.e. persons who buy and sell the hide, pelt or fur of fur-bearing animals). The VDGIF conducts an annual survey of licensed fur dealers to quantify the number of fur-bearer pelts they purchase or broker from Virginia trappers or

hunters and the number of pelts they trapped themselves. This information can be used as an index of furbearer populations (e.g., see Fies 2010*a*).

Annual Trapper Harvest Estimates

Trapping seasons are established and enforced by the VDGIF. The VDGIF does not survey licensed trappers on a regular basis. However, a survey of these individuals was conducted in 2013–2014 to determine the number of animals they harvested. This information can be used in conjunction with annual fur dealer reports as an index of furbearer populations.

Issue 2 - Effects of Damage Management Activities on Dogs

A concern of the public and the professional community alike when addressing damage is the potential impact of management actions on dogs. This concern includes dogs causing damage as well as dogs not causing damage that could be captured or killed by methods used to resolve damage to livestock. Dogs have been owned and valued as pets, working and hunting companions since the Commonwealth's days as a British colony (Breig 2004, Hood 2006). However, dogs have been recognized as a threat to livestock for just as long (Breig 2004). A 1769 petition noted the, "great injury and loss that we sustain in our flocks of sheep, by the dogs which are suffered to run at large…'tis notorious that the dogs are worse than wolves" (Breig 2004).

Dogs are classified as companion animals in the Code of Virginia and are managed by local law enforcement and animal control authorities. Dogs may be; 1) owned and under the owner's direct control, 2) owned but free-ranging (not under the owner's direct control), 3) feral (ownerless or homeless wild dog), 4) owned hybrid (animals that are the progeny of a domestic dog and any other species of the Canidae family) under the owner's direct control, 5) owned but free-ranging hybrid or 6) feral hybrid. The Code of Virginia recognizes the potential damage dog and hybrid canines can cause. Dogs or hybrid canines, "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock", can be seized or lethally removed (§ 3.2-6552, § 3.2-6583).

Methods available to resolve damage or threats of damage can be categorized as lethal and non-lethal. Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive or unavailable to the species (target species) causing the damage, thereby reducing the presence of those species in the area. However, non-lethal methods also have the potential to inadvertently disperse non-targets. Lethal methods remove individuals of target species causing the damage, thereby reducing the presence of those species in the area. However, lethal methods also have the potential to inadvertently capture or kill non-targets. The number of target species lethally removed under the alternatives is dependent upon the magnitude of the damage occurring, the level of damage acceptable to individual persons experiencing the damage, the numbers of individual animals involved, and the efficacy of methods employed. Under certain alternatives, both non-lethal and lethal methods could be recommended, as governed by federal, state, and local laws and regulations.

The analysis to determine the impacts on dogs from the use of lethal methods would be based on a measure of the number of individuals captured or killed. Methods would only be used by WS at the request of those persons seeking assistance. Any activities conducted by WS under the alternatives addressed would occur along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, local law enforcement and animal control authorities.

Issue 3 - Effects of Damage Management Activities on Non-target Animals, Including Threatened and Endangered Species

A common issue when addressing damage caused by animals are the potential impacts of management actions on non-target species, including threatened and endangered species. Non-lethal methods have the potential to inadvertently disperse or otherwise impact non-targets. Lethal methods remove individuals of the species (target species) causing the damage, thereby reducing the presence of those species in the area and the local population. However, lethal methods also have the potential to inadvertently capture or kill non-targets.

The Endangered Species Act (ESA) makes it illegal for any person to '*take*' any listed endangered or threatened species or their critical habitat. The ESA defines take as, "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 USC 1531-1544). Critical habitat is a specific geographic area or areas that are essential for the conservation of a threatened or endangered species. The ESA requires that federal agencies conduct their activities in a way to conserve species. It also requires that federal agencies consult with the appropriate implementing agency (either the USFWS or the NMFS) prior to undertaking any action that may take listed endangered or threatened species or their critical habitat pursuant to Section 7(a)(2) of the ESA.

There may also be concerns that WS' activities could result in the disturbance of eagles that may be near or within the vicinity of WS' activities. Under 50 CFR 22.3, the term "disturb", as it relates to take under the Bald and Golden Eagle Act, has been defined as "to agitate or bother a bald and golden eagles to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." The environmental consequences evaluation conducted in Chapter 4 of this EA will discusses the potential for WS' activities to disturb eagles as defined by the Act.

Issue 4 - Effects of Damage Management Activities on Human Health and Safety

An additional issue often raised is the potential risks to human health and safety associated with the methods employed to manage damage caused by coyotes, dogs and red foxes. Both chemical and non-chemical methods have the potential to have adverse effects on human health and safety. Risks can occur to persons employing methods and to persons coming into contact with methods. Risks can be inherent to the method itself or related to the misuse of the method.

Safety of Chemical Methods Employed

Potential risks to human health and safety associated with chemical methods are related to the potential for human exposure either through direct or indirect contact with the chemical. Under the alternatives analyzed in detail, chemical methods could include predacides which are chemicals used to lethally remove predators. Predacides registered for use in Virginia include, livestock protection collars (LPCs) (Compound 1080 EPA No. 56228-22), M-44s (sodium cyanide (NaCN) EPA No. 56228-15), and large gas cartridges (EPA No. 56228-21).

Large gas cartridges are non-restricted use pesticides and the only predacide available for use by the public. Large gas cartridges would be available for use under any of the alternatives. When ignited, gas cartridges which contain sodium nitrate ($NaNO_3$) and carbon produce poisonous carbon monoxide gas (CO). The ignited cartridges are placed inside active coyote or red fox den and the entrance to the den is then covered with dirt allowing the carbon monoxide to act as a fumigant.

The use of chemical methods is strictly regulated by the EPA, FDA and VDACS. M-44s and LPCs can only be applied by persons who have been specially trained and certified by the VDACS for their use. These persons (certified applicators) are required to take continuing education credits and exams to maintain their certification. Each of the chemical methods listed above, including gas cartridges, have specific requirements for their handling, transport, storage, use and disposal under the Code of Virginia and the Virginia Administrative Code. Additional information about these methods can be found in Appendix B.

Safety of Non-Chemical Methods Employed

Most methods available to manage damage and threats associated with coyotes, dogs and red foxes are considered non-chemical methods. Non-chemical methods available can be grouped into two categories; non-lethal and lethal. Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive or unavailable to the species (target species) causing the damage, thereby reducing the presence of those species in the area. Examples of non-lethal methods include resource management, physical exclusion, deterrents or live traps. All of these methods are designed to disperse, exclude or make the area where damage is occurring unattractive to the animals which are associated with the damage. Lethal methods remove individuals of target species causing the damage, thereby reducing the presence of those species in the area and reducing the local population. Lethal methods include shooting, capture and euthanasia, or the reduction of a local population by hunting. All of these non-chemical methods available to address damage to livestock associated with coyotes, dogs and red foxes in Virginia would be available for use under any of the alternatives and could be employed by any entity, when permitted.

Like chemical methods, non-chemical methods, if misused, could potentially be hazardous to human health and safety. The primary safety risk of most non-chemical methods occurs directly to the person employing the method. However, risks to others do exist when employing non-chemical methods, such as when using firearms and livestock protection dogs. All of the non-chemical methods available to address damage to livestock associated with coyotes, dogs and red foxes in Virginia would be available for use by any entity, when permitted, under all of the alternatives analyzed in detail.

Issue 5 – Humaneness and Animal Welfare Concerns

The issue of humaneness and animal welfare, as it relates to the killing or capturing of animals is an important but very complex concept that can be interpreted in a variety of ways. 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*."

Suffering has previously been described by the American Veterinary Medical Association (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.

Defining pain as a component in humaneness 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 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"* (AVMA 2001).

Pain and suffering, as it relates to methods available for use to manage animal damage has both a professional and lay point of arbitration. The professional community and the public would be better served to recognize the complexity of defining suffering, because *"…neither medical nor veterinary curricula explicitly address suffering or its relief"* (California Department of Fish and Game 1991). Research suggests that some methods can cause *"stress"* (Kreeger et al. 1990). However, such research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991).

The decision-making process can involve trade-offs between the above aspects of pain and humaneness. Therefore, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal, and 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.

The issue of humanness and animal welfare concerns, as those concerns relate to the methods available for use, will be further discussed under the alternatives in Chapter 4. SOPs to alleviate pain and suffering are discussed in Chapter 3.

Issue 6 – Effects of Damage Management Activities on the Aesthetic Values of Coyotes, Dogs and Red Foxes

An additional issue raised is that activities to alleviate damage and threats to livestock associated with coyotes, dogs and red foxes would result in the loss of the aesthetic benefits of coyotes, dogs and red foxes to persons in the area where damage management activities take place. Animals are generally regarded as providing utilitarian, monetary, recreational, scientific, ecological, existence and historic values (Conover 2002). These benefits can be tangible, or intangible. Both recreational and existence values are related in part to aesthetics. Aesthetics is the philosophy dealing with the nature of beauty or the appreciation of beauty. Therefore, aesthetics is truly subjective in nature and dependent upon what an observer regards as beautiful.

Many people enjoy watching or hearing coyotes and red foxes and take pleasure from knowing they exist. In modern societies a large percentage of households have pets. However, some people may consider individual wild animals including coyotes and red foxes as "pets" and exhibit affection towards these animals.

Dogs are classified as companion animals in the Code of Virginia and are managed by local law enforcement and animal control authorities. The aesthetic value of dogs may for some people be linked to their status (i.e. owned and under the owner's direct control, owned but free-ranging or feral). Some owners may never confine or restrain their pet and enjoy knowing they have the freedom of being free-ranging. These people may view their pet differently than an un-owned free-ranging or feral animal. The Code of Virginia recognizes the potential damage dogs and hybrid canines can cause. Dogs or hybrid canines, "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock", can be seized or lethally removed (§ 3.2-6552, § 3.2-6583).

The values people place on animals is unique to the individual and can be based on many factors. Because these values differ, public attitudes toward animals vary considerably. To alleviate damage, some people support lethal removal, some people believe that all animals should be captured and relocated or handed over to local law enforcement or animal control authorities while others strongly oppose any management and want management agencies to teach tolerance. Some of the people who oppose removal do so because of human-affectionate bonds with individual animals. Attitudes can also differ significantly depending upon if the individual is affected by the damage or threats of damage.

As stated previously, methods available to alleviate damage or reduce threats either disperse or otherwise make an area where damage is occurring unattractive or unavailable to the species (target species) causing the damage, or alternatively lethally remove individuals of the species causing the damage. These activities reduce the presence of target species in the area where damage is occurring. Therefore, these activities have the potential to affect the aesthetic values of coyotes, dogs and red foxes depending upon the values, philosophies, attitudes and opinions of individuals.

Issue 7 – Effects of Damage Management Activities on the Regulated Harvest of Coyotes and Red Foxes

Another issue commonly identified as a concern is that damage management activities conducted by WS could affect the ability of hunters or trappers to harvest species targeted by management activities. Potential impacts could arise from both lethal and non-lethal damage management methods. Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive to the species (target species) causing the damage, thereby reducing the presence of those species in the area. Lethal methods remove individuals of the species (target species) causing the damage, thereby reducing the local population and the presence of those species in the area. Therefore, lethal methods could reduce the local population or the presence of coyotes or red foxes in the area where damage management activities are occurring. In the Commonwealth, coyotes and red foxes may be harvested by hunters and trappers.

2.3 ISSUES CONSIDERED BUT NOT IN DETAIL, WITH RATIONALE

Additional issues were identified by WS during the scoping process of this EA. Those issues were considered by WS during the development of this EA. However, those issues will not be analyzed in detail for the reasons provided. The following issues will not be analyzed in detail in this EA:

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

WS has the discretion to determine the geographic scope of their analyses under the NEPA. The intent in developing this EA is to determine if the proposed action would potentially have significant individual and/or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS or a finding of no significant impact (FONSI). In terms of considering cumulative effects, one EA analyzing impacts for the entire state will provide a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. As most mammals are regulated by the VDGIF, the best available data for analysis is often based on statewide population dynamics. For example, an EA on county level may not have sufficient data for that area and would have to rely on statewide analysis anyway. If a determination is made through this EA that the proposed action or the other alternatives might have a significant impact on the quality of the human environment, then an EIS would be prepared.

Effects of Coyote, Dog and Red Fox Damage Management Activities on Biodiversity

Another issue identified as a concern is that managing coyote, dog and red fox damage to livestock could affect biodiversity or the diversity of species. When managing damage, WS does not attempt to eradicate any species of native wildlife. The purpose of damage management is to reduce or alleviate the damage or threats of damage by targeting individuals or groups of animals identified as causing damage or posing a threat of damage. Coyote and red fox are managed by the VDGIF. Lethal removal of coyotes and red foxes can only occur at the discretion of the VDGIF, which ensures that removal occurs to achieve desired population objectives for these species. Dogs are managed by local law enforcement and animal control authorities. Therefore, any decision regarding the management of feral dog populations occurs at their discretion. Any reduction of a local population would be temporary because immigration from adjacent areas or reproduction would replace those animals removed. Therefore, damage management activities conducted pursuant to any of the alternatives would not adversely affect biodiversity.

A Loss Threshold Should Be Established Before Allowing Lethal Methods

An issue commonly identified as a concern is that a threshold of damage or economic loss should be established and reached before lethal methods can be used to resolve damage and that damage caused by coyotes, dogs or red foxes should be a cost of doing business. For any given damage situation, there are varying thresholds of tolerance exhibited by those people affected. The point at which people begin to implement damage management methods are often unique to the individual and can be based on many factors (e.g., economic, social, aesthetics). How damage is defined is also often unique to the individual and damage occurring to one individual may not be considered damage by another individual. Therefore the threshold of damage or economic loss that can be tolerated is also unique to the individual.

Effects from the Use of Lead Ammunition in Firearms

Questions have arisen about the deposition of lead into the environment from ammunition used in firearms. Under any of the alternatives, coyotes, dogs or red foxes causing damage or posing threats to livestock could be lethally removed with firearms. Lead is a metal that can be poisonous to animals. Risk of lead exposure to animals occurs primarily when they ingest lead shot or bullet fragments. Lead ammunition may be used by any person implementing damage management methods under any of the alternatives.

Deposition of lead into soil could occur if, during the use of a rifle, the projectile passes through an animal, if misses occur, or if the carcass is not retrieved. Laidlaw et al. (2005) reported that, because of the low mobility of lead in soil, all of the lead that accumulates on the surface layer of the soil is generally retained within the top 20 cm (about 8 inches). In addition, concerns have been raised that lead from bullets introduced into the environment from shooting activities could lead to the contamination of either ground water or surface water from runoff. Stansley et al. (1992) studied lead levels in water that was directly subjected to high concentrations of lead shot because of intensive target shooting at shooting ranges. Lead did not appear to "*transport*" readily in surface water when soil at the shooting ranges were neutral or slightly alkaline in pH (*i.e.*, not acidic), but lead did transport more readily under slightly acidic conditions. However, Stansley et al. (1992) did detect elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at one shooting range, but did not find higher lead levels in a lake into which the stream drained, with the exception of 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. Stansley et al. (1992) also indicated that even when lead shot has accumulated in high levels in areas with permanent water bodies present, the lead does not necessarily cause elevated lead contamination of water downstream. Muscle samples from two species of fish collected in water bodies with high levels of lead shot 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 Environmental Protection Agency (EPA) (*i.e.*, requiring action to treat the water to remove lead). The study found that the dissolution (*i.e*., capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments (Craig et al. 1999). Therefore, the transport of lead from bullets or shot distributed across the landscape is reduced once the bullets and shot form crusty lead oxide deposits on their surfaces, which serves to further reduce the potential for ground or surface water contamination (Craig et al. 1999). These studies suggest that the very low amounts of lead that could be deposited from damage management activities would have minimal effects on lead levels in soil and water.

Since the lethal removal of coyotes can occur at any time, lethal removal of dogs or hybrid canines can occur when they are "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock"(§ 3.2-6552, § 3.2-6583) and lethal removal of foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee, or during hunting and trapping seasons, WS' assistance with removing coyotes, dogs or red foxes causing damage or threats of damage to livestock would not be additive to the environmental status quo. The amount of lead deposited into the environment may be lowered by WS' involvement in activities due to efforts by WS to ensure projectiles do not pass through, but are contained within the carcass, which would limit the amount of lead potentially deposited into soil from projectiles passing through the carcass. The proficiency training received by WS' employees in firearm use and accuracy increases the likelihood that animals are lethally removed humanely in situations that ensure accuracy and that misses occur infrequently, which would further reduce the potential for lead to be deposited in the soil from misses or from projectiles passing through carcasses. In addition, WS' involvement would ensure efforts were made to retrieve and dispose of carcasses lethally removed using firearms to prevent the ingestion of lead in carcasses by scavengers. Based on current information, the risks associated with lead bullets that would be deposited into the environment from WS' activities due to misses, the bullet 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.

Damage Management Should Not Occur at Taxpayer Expense

An issue was raised that damage management should not be provided at the expense of taxpayers. Activities conducted by WS to manage damage or threats to livestock associated with coyotes, dogs and red foxes in Virginia may be funded by a variety of sources including, but not limited to, federal appropriations, the Commonwealth of Virginia, other cooperative funding, and a tax on sheep sold in Virginia. These activities include both technical assistance and direct operational assistance, when requested. Under the proposed action, funding could come from these and/or other sources. A federal appropriation is allotted for the maintenance of the Virginia WS program. The remainder of the Virginia WS program is funded by cooperative, federal, and non-federal funding. WS is specifically authorized by the Act of March 2, 1931 (46 Stat. 1468; 7 USC 426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 426c) to conduct predator management and make expenditures for this purpose.

Global Climate Change / Greenhouse Gas Emissions

The WS program activities that may result from the alternatives would have a negligible effect on atmospheric conditions including the global climate. Meaningful direct or indirect emissions of greenhouse gases would not occur as a result of the proposed action. The proposed action would meet

requirements of applicable federal laws, regulations, and Executive Orders including the Clean Air Act and Executive Order 13514.

Coyote Populations May Respond to Lethal Removal through Compensatory Reproduction

An issue identified as a concern is that coyotes compensate for reductions in their population by reproducing at an earlier age and having more pups per litter.

This issue makes the assumption that the coyote population in Virginia currently exists at a level where the implementation of the alternatives would remove enough coyotes alone or cumulatively to a level in which coyotes would compensate reproductively. The alternatives are intended to mitigate damage to livestock and not have significant direct or cumulative impacts on coyote populations. Additionally, this issue makes the assumption that coyotes lethally removed because they are causing damage will be replaced by coyotes that will be equally as likely to cause damage to livestock. However, not all coyotes cause damage to livestock (Shivik et al. 1996) even when deprived of food and given ample opportunity (Connolly et al. 1976, USFWS 1978, Timm and Connolly 1980).

CHAPTER 3: ALTERNATIVES

Chapter 3 contains a discussion of the alternatives developed to address the identified issues discussed in Chapter 2. Alternatives were developed for consideration based on the issues using the WS Decision model (Slate et al. 1992). The alternatives will receive detailed analysis in Chapter 4. Chapter 3 also discusses alternatives considered but not analyzed in detail, with rationale. Standard operating procedures (SOPs) for damage management in Virginia are also discussed in Chapter 3.

3.1 DESCRIPTION OF THE ALTERNATIVES

The following alternatives were developed to address the identified issues associated with managing damage to livestock caused by coyotes, dogs and red foxes:

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

The proposed action/no action alternative would continue the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques, as deemed appropriate using the WS Decision Model, to reduce damage and threats to livestock associated with coyotes, dogs and red foxes in Virginia. Under this alternative, WS could respond to requests for assistance for managing damage and threats to livestock associated with coyotes, dogs and red foxes by: 1) taking no action, if warranted, 2) providing technical assistance to property owners or managers on actions they could take to reduce damage or threats of damage, or 3) provide technical assistance and direct operational assistance to a property owner or manager experiencing damage or threats of damage. Technical assistance is the provision of recommendations, information or materials for use in managing damage. Direct operational assistance is the implementation of management activities by WS personnel. Direct operational assistance could be provided when funding is available through federal appropriations, the Commonwealth of Virginia, taxes on sheep sold in Virginia or other sources. However, WS response to requests for assistance is dependent upon on those persons initiating the request. Those persons receiving technical assistance can 1) take no action, 2) choose to implement WS' recommendations on their own, 3) use the services of a private nuisance wildlife control agent, 4) use volunteer services of private individuals or organizations (e.g. private trappers or predator hunters), 5) use the services of local law enforcement or animal control authorities (in the case of dogs) or 6) use the services of WS (direct

operational assistance) when available. Direct operational assistance would only be conducted by WS after a memorandum of understanding, cooperative service agreement, or other comparable document listing all the methods the property owner or manager will allow to be used on property they own and/or manage was signed by WS and those requesting assistance.

WS personnel use a thought process for evaluating and responding to requests for assistance detailed in the WS Decision Model (see WS Directive 2.201) and described by Slate et al. (1992). After receiving a request for assistance, a determination is made as to whether the problem is within the authority of WS. If it is, information about the damage is gathered and analyzed (e.g., what species is responsible for the damage, the type of damage occurring, magnitude of the damage occurring, previous actions taken to address the problem). WS then evaluates the appropriateness of strategies and methods based on their availability (i.e., legal and administrative) and suitability based on biological, environmental, social and economic factors (see WS Directive 2.101). Methods deemed practical for the situation are then developed into a management strategy and this information is provided to the requestor in the form of technical assistance. WS would continue to monitor and evaluate the situation as assistance is provided, modifying the strategy and methods used to reduce the damage to an acceptable level.

The most effective approach to resolving any animal damage problem is to use an adaptive integrated approach that may call for the use of several methods simultaneously or sequentially. This approach, used by WS for providing both technical assistance and direct operational assistance, is commonly known as integrated management (see WS Directive 2.105). The philosophy behind integrated management is to implement methods in the most effective manner while minimizing the potentially harmful effects to humans, target and non-target species, and the environment[5]. Integrated damage management may incorporate both non-lethal and lethal methods depending upon the circumstances of the specific damage problem. Non-lethal methods disperse or otherwise make an area where the damage is occurring unattractive or unavailable to the species causing the damage, thereby reducing the presence of those species in the area. Lethal methods remove individuals of the species causing the damage, thereby reducing the presence of those species in the area and the local population. Appendix B contains a thorough discussion of the methods available for use in managing damage and threats to livestock associated with coyotes, dogs and red foxes under this alternative. All of the methods listed in the Appendix would be available under this alternative although not all methods would be available for direct implementation by all persons. Livestock protection collars (Compound 1080) and M-44s (sodium cyanide) are only available for use by WS.

Technical Assistance

Technical assistance is the provision of information, recommendations, and demonstrations on available and appropriate methods. It may also include the provision or assistance in the acquisition of supplies or materials not readily available. The implementation of these methods to resolve damage and threats to livestock is entirely the responsibility of the requester with no direct involvement by WS. Technical assistance involves collecting information about the nature and extent of the damage, the species involved, the number of individual animals involved and previous actions taken to address the problem. Using the WS Decision Model, WS then provides information on appropriate methods that the requestor may consider to resolve damage or threats. This process may include visits to the location where damage or threats are occurring, written information, telephone conversations, presentations or demonstrations. Generally, several management strategies are described to the requestor for short and long-term solutions to damage problems. These strategies are based on the level of risk, need, and the practicality of their application. In some instances, the provision of information about the wildlife results in tolerance and / or

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

acceptance of the situation. In other instances, management options are discussed and recommended. Only those methods legally available for use by the appropriate individual would be recommended by WS.

Education

An important component of technical assistance is education. Education is important because wildlife damage management is about finding compromise and coexistence between the needs of people and needs of wildlife. This is extremely challenging as nature has no balance, but rather is in continual flux. In addition to the dissemination of information and recommendations to those persons requesting assistance with reducing damage or threats, WS provides lectures, courses, and demonstrations to producers, homeowners, Commonwealth and county agents, colleges and universities, and other interested groups on damage management. Additionally, technical papers are presented at professional meetings and conferences so that other natural resource professionals are kept up to date on recent developments in damage management technology, programs, agency policies, laws and regulations.

Research and Development

Another important component of technical assistance is the development of new methods. The National Wildlife Research Center (NWRC) functions as the research unit of WS. NWRC uses scientific expertise to develop methods to resolve conflicts between humans and animals while maintaining the quality of the human environment. NWRC research biologists work closely with wildlife managers, researchers, and others to develop and evaluate damage management techniques. NWRC biologists have authored hundreds of scientific publications and reports, and are respected worldwide for their expertise.

Direct Operational Assistance

Direct operational assistance can only commence after technical assistance has been provided (see WS Directive 2.101, WS Directive 2.201) and those persons requesting assistance have been informed of their options (see WS Directive 3.101). Those persons receiving technical assistance can 1) take no action, 2) choose to implement WS' recommendations on their own, 3) use the services of a private nuisance wildlife control agent, 4) use volunteer services of private individuals or organizations (e.g. private trappers or predator hunters), 5) use the services of local law enforcement or animal control authorities (in the case of dogs), or 6) use the services of WS (direct operational assistance) when available. Direct operational assistance could be provided when funding is available through federal appropriations, the Commonwealth of Virginia, taxes on sheep sold in Virginia or other sources. Direct operational assistance would only be conducted by WS after a memorandum of understanding, cooperative service agreement, or other comparable document listing all the methods the property owner or manager will allow to be used on property they own and/or manage was signed by WS and those requesting assistance.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock from coyotes, dogs or red foxes with technical assistance only. Technical assistance would be provided as described above under Alternative 1. Appendix B contains a thorough discussion of the methods available for use in managing damage and threats to livestock associated with coyotes, dogs or red foxes. With the exception of Livestock protection collars (Compound 1080) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those

persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock associated with as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not conduct technical or direct operational assistance to reduce threats or alleviate damage to livestock associated with coyotes, dogs or red foxes. WS would not be involved with any aspect of managing damage to livestock associated with coyote, dog or red fox. All requests for assistance received by WS to resolve damage caused by coyotes, dogs or red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities. This alternative would not prevent other federal, Commonwealth, and/or local agencies, including private entities from conducting damage management activities directed at alleviating damage and threats to livestock associated with coyotes, dogs or red foxes. Similar to Alternative 2, with the exception of Livestock protection collars (Compound 1080) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative.

Similar to Alternative 2, this alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock associated with coyotes, dogs or red foxes as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

3.2 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL WITH RATIONALE

In addition to those alternatives analyzed in detail, several alternatives were identified by WS that will not receive detailed analyses for the reasons provided. Those alternatives considered but not analyzed in detail include:

WS Would Implement Non-lethal Methods before Lethal Methods

This alternative would require that all non-lethal methods or techniques described in Appendix B be applied to all requests for assistance to reduce damage and threats to livestock associated with coyotes, dogs or red foxes. Non-lethal methods would be applied to every request for assistance regardless of severity or intensity of the damage or threat until deemed inadequate to resolve the damage. If the use of all non-lethal methods failed to resolve the damage or threat, lethal methods would then be employed to resolve the damage.

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

WS Would Use Non-lethal Methods Only

Under this alternative, the only methods available for recommendation and use in resolving damage or threats to livestock associated with coyotes, dogs and red foxes would be the non-lethal methods described in Appendix B. The non-lethal methods recommended or used under this alternative would be identical to those identified under Alternatives 1, 2 and 3.

In situations where non-lethal methods were impractical or ineffective to alleviate damages, WS would refer requests for information regarding lethal methods to the VDGIF, the VDACS and/or private entities. Although not recommended or used by WS, lethal methods could continue to be used by others in resolving damage or threats to livestock associated with coyotes, dogs and red foxes under this alternative. Similar to Alternative 2 and 3, with the exception of Livestock protection collars (Compound 1080) and M-44s (sodium cyanide), all lethal methods listed in the Appendix would be available under this alternative.

Under this alternative, livestock owners or managers frustrated by a lack of WS' assistance with the full range of management methods may try methods not recommended by WS (e.g., poisons). In some cases, livestock owners or managers may misuse methods or use methods in excess of what is necessary.

This alternative was not analyzed in detail since the lethal removal of coyotes, dogs and red foxes could continue at the levels analyzed in Alternative 1, despite the lack of WS' involvement.

WS Would Only Trap and Translocate Coyotes, Dogs and Red Foxes

Under this alternative, all requests for assistance would be addressed using live-capture methods or the recommendation of live-capture methods described in Appendix B followed by translocation (the transport and release of an animal from one area to another). Coyote and red fox are managed by the VDGIF and translocation of coyotes and red foxes could only occur under the authority of the VDGIF. Dogs are classified as companion animals in the Code of Virginia and are managed by local law enforcement and animal control authorities. The translocation of dogs by WS or other entities is considered animal abandonment and a misdemeanor in Virginia (Code of Virginia § 3.2-6504). Therefore, translocation of dogs could not legally occur and was not analyzed further.

Translocation of animals is generally ineffective in reducing damage and would therefore be ineffective at meeting the need for action because animals are highly mobile and can easily return to damage sites from long distances, and translocation may result in damage problems at the new location (Fischer and Lindenmayer 2000, Seddon et al. 2012). Carnivores show strong homing behavior (Bradley et al. 2005); and coyotes have been observed traveling straight line distances of 233 miles (Elfelt 2014) while red foxes have been observed traveling as far as 105 miles (Rosatte 2002). Many carnivores continue to depredate livestock after being translocated (Bradley et al. 2005). Additionally, given the scope of the issue described in the need for action (Chapter 1), it would be unrealistic to translocate the numbers of animals necessary to reduce damage to livestock. There is a perception among some individuals that animals which are translocated because they are causing damage 'live happily ever after' (Craven et al. 1998). Unfortunately however, these animals typically have high mortality rates because of the stress of capture, transport and release, aggression by animals of the same species already occupying the new location, disorientation, unsuitable habitat, difficulties finding resources (food, water, shelter) at the new location, attempts to return to the site of capture and increased susceptibility to predation or disease (Nielsen 1988, Craven et al. 1998, Fischer and Lindenmayer 2000, Seddon et al. 2012). Translocation of animals may also result in the transmission of diseases from one area to another (Nielsen 1988). For these reasons, translocation of wildlife is discouraged by WS policy (see WS Directive 2.501) and was not analyzed further.

WS Would Use Lethal Methods Only

Under this alternative, the only methods available for recommendation and use in resolving damage or threats to livestock associated with coyotes, dogs and red foxes would be the lethal methods described in Appendix B. This is in direct conflict with WS Directive 2.101, which directs that WS must consider the use of non-lethal methods before lethal methods. Therefore, this alternative was not considered in detail.

WS Would Implement a Bounty System or Other Means to Reduce the Commonwealth's Coyote Population

This alternative would require WS to implement a coyote bounty or other means to reduce the Commonwealth's coyote population. The assumption of bounty systems is that people will increase their lethal removal in exchange for financial compensation (Bartel and Brunson 2003). WS does not have the authority to establish a bounty system. The management of coyotes is the responsibility of the VDGIF (VAC§§29.1-103) and the authority to implement bounties is held by localities (VAC §§15.2-926.1). WS does not have the authority to manage the Commonwealth's coyote population, only the damage or threats of damage associated with coyotes, within the parameters established by the VDGIF. The implementation of bounties would not be recommended by WS to reduce damage and threats to livestock for several reasons.

First, damage and threats to livestock may or may not be directly related to coyote abundance (Robel et al. 1981, Knowlton et al. 1999, Stoddart et al. 2001, Sacks and Neale 2002, Mitchell et al. 2004, Sacks and Neale 2007). Additionally, not all coyotes cause damage to livestock (Shivik et al. 1996) even when deprived of food and given ample opportunity (Timm and Connolly 1980, Connolly et al. 1976). Most coyotes are territorial and each territory is typically controlled and maintained by a dominant breeding pair (Gese and Ruff 1997; 1998) and their subordinates (Bekoff and Wells 1986; Gese et al. 1996*a*, 1996*b*; Camenzind 1978). In a series of field studies (Conner et al. 1998, Sacks et al. 1999*b*, Blejwas et al. 2002) breeding or "alpha" coyotes whose territories overlapped sheep pastures were the individuals who killed sheep. Non-breeding coyotes rarely killed sheep. Observations of coyotes with known status attacking white-tailed deer (*Odocoileus virginianus*) and elk (*Cervus elaphus*) support this (Gese and Grothe 1995). This evidence suggests breeding territorial coyotes are responsible for livestock damage. The ratio of breeding coyotes to non-breeding subordinates is primarily a function of food abundance and distribution (Gese et al. 1988, Atwood 2006). Therefore, damage and threats to livestock is likely to be related to the abundance of breeding coyotes on the landscape; however the abundance of breeding coyotes compared to non-breeders is variable because it is a function of food abundance and distribution.

Second, bounties are unlikely to remove enough coyotes to impact the population. When coyotes are lethally removed they are either replaced by transients, dispersing individuals or if these individuals are not available by reproductive compensation (Knowlton et al. 1999). Models have been developed to illustrate what happens to a coyote population when different percentages of the population are lethally removed (Connolly and Longhurst 1975, Pitt et al. 2001 see also Connolly 1995). Connolly and Longhurst (1975) found that the population would only decline to zero after 50 years of removing 75% of the coyote population every year, if no transients or dispersing individuals were ever available during that 50 year period (Connolly 1995). Research indicates that transients and dispersing individuals exist in the Virginia population and the population of surrounding states (Elfelt 2014). A model developed more recently which included the effect of additional population factors found that when less than 60% of the coyotes were removed in a single year, the population recovered within a year and when 90% were removed in a single year the population recovered in five years (Pitt et al. 2001). Conner et al. (2008) examined the effects of different management strategies on coyote populations using an even more detailed model. The authors found that spatially intensive lethal removal had more long lasting effects

compared to random lethal removal. In a study examining Utah's coyote bounty program, the authors found that its implementation failed to reduce the coyote population or reduce the damage occurring to livestock (Bartel and Brunson 2003). Additionally, they could not find any evidence that any other bounty has ever reduced coyote abundance or subsequently reduced damage occurring to livestock (Bartel and Brunson 2003).

Finally, bounties do not generally remove coyotes in locations where damage and threats to livestock are occurring. Bounties encourage the removal of coyotes at times and in places where coyotes are easiest to remove (Collinge and Maycock 1997). This may or may not occur in locations or in close proximity to locations where damage to livestock is occurring. Again, the need for action is not to remove the maximum number of coyotes but to manage the damage to livestock associated with coyotes.

WS Would Provide Financial Compensation for Damage to Livestock Associated with Coyotes, Dogs or Red Foxes

Under this alternative, WS would provide financial compensation to those persons requesting assistance who were experiencing damage to livestock associated with coyotes, dogs or red foxes. This alternative would include site visits to verify damage and identify the species involved. WS would not provide direct operational assistance. The assumption of financial compensation programs for animal damage is that offsetting damages financially can reduce or eliminate any incentive for those persons experiencing damage to lethally remove animals (Bulte and Rondeau 2005).

Dogs in the Commonwealth of Virginia are managed by local law enforcement and animal control authorities. The Code of Virginia authorizes localities to, provide compensation for livestock killed or injured by dogs or hybrid canines if particular criteria can be met (§ 3.2-6534, 3.2-6553, 3.2-6584). However, no compensation program exists for offsetting damage to livestock caused by coyotes and red foxes. The management of coyotes and red foxes is the responsibility of the VDGIF. WS does not have the legal authority to provide financial compensation for damage to livestock; only manage the damage or threats of damage.

This EA evaluates different alternatives to meet the need for action. The need for action is to reduce damage and threats to livestock associated with coyotes, dogs and red foxes. Providing financial compensation to those persons experiencing damage to livestock would be ineffective at meeting the need for action because it does not reduce damage and threats to livestock. Because providing financial compensation would fail to meet the need for action, this alternative was not considered further.

WS Would Refer All Requests for Assistance in Managing Damage and Threats to Livestock Associated with Coyotes, Dogs or Red Foxes to Other Entities

Under this alternative, WS would refer all persons requesting assistance in managing damage and threats to livestock associated with coyotes, dogs or red foxes to the VDGIF, the VDACS, private nuisance wildlife control agents, private trappers, predator hunters, local law enforcement or animal control authorities. This alternative is identical to Alternative 3 and was therefore eliminated from further analysis.

3.3 STANDARD OPERATING PROCEDURES FOR COYOTE, DOG AND RED FOX DAMAGE MANAGEMENT

WS' directives and standard operating procedures (SOPs) improve the safety, selectivity, and efficacy of animal damage management activities. WS' directives and SOPs would be incorporated into activities

conducted by WS when addressing damage and threats to livestock associated with coyotes, dogs or red foxes.

Some key SOPs pertinent to the proposed action and the alternatives include the following:

- The WS' Decision Model, designed to identify the most appropriate damage management strategies and their potential impacts, would be used to determine damage management strategies.

- All pesticides have to be registered with the Environmental Protection Agency (EPA) and the VDACS, and must have labels approved by the agency which details the product's ingredients, the type of pesticide, the formulation, classification, approved uses and formulations, potential hazards to humans, animals and the environment as well as directions for use. The registration process for pesticides is intended to assure minimal adverse effects to humans, animals and the environment when chemicals are used in accordance with label directions. Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and its implementing guidelines, it is a violation of federal law to use any pesticide in a manner that is inconsistent with its label. WS would follow and use all pesticides according to their label.

- Non-target animals captured in traps would be released unless it was determined that the animal would not survive and/or that the animal could not be released safely.

- WS has consulted with the USFWS to determine the potential risks to federally listed threatened and endangered species in accordance with the ESA.

- All personnel who would use chemicals would be trained and certified to use such substances or would be supervised by trained or certified personnel.

- All personnel using firearms would be trained according to WS' Directives.

- Damage management activities would be conducted professionally and in the safest manner possible.

- All chemicals used by WS or recommended by WS would be registered with the EPA and the VDACS.

- The use of non-lethal methods would be considered prior to the use of lethal methods when providing technical assistance and direct operational assistance.

- Management actions would be directed toward specific animals or groups of animals causing damage or threats to livestock.

- WS use of traps, snares (cable devices) or other devices would comply with WS Directive 2.450, 2.450(b).

- Direct operational assistance would only be conducted by WS after a memorandum of understanding, cooperative service agreement, or other comparable document listing all the methods the property owner or manager will allow to be used on property they own and/or manage was signed by WS and those requesting assistance. In addition, this document may advise those persons requesting assistance contact and inform those persons utilizing or

adjoining the property they own and/or manage of control activities. WS verbally advises those persons requesting assistance contact and inform those persons utilizing or adjoining the property they own and/or manage of control activities.

- Appropriate warning signs will be posted in accordance with WS Directive 2.450.

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

- WS would comply with all applicable federal, Commonwealth, and local laws and regulations in accordance with WS Directive 2.210.

- WS' personnel would use bait, trap placements, and capture devices that are strategically placed at locations likely to capture a target animal and minimize the potential of non-target animal captures.

3.4 ADDITIONAL STANDARD OPERATING PROCEDURES SPECIFIC TO THE ISSUES

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

Issue 1 - Effects of Damage Management Activities on Coyote and Red Fox Populations

- The lethal removal of coyotes and red foxes by WS could only occur within the parameters established by the VDGIF.

- Lethal removal of coyotes and red foxes by WS would be monitored by the VDGIF to ensure cumulative lethal removal is considered as part of population management objectives.

- WS would monitor coyote and red fox damage management activities to ensure activities do not adversely affect coyote and red fox populations in the Commonwealth.

Issue 2 - Effects of Damage Management Activities on Dogs

- WS would conduct dog management in coordination with state and local authorities with jurisdiction over dog control in accordance with WS Directive 2.340. In urban areas, WS will refer requests for assistance to the local animal control or law enforcement authority in accordance with WS Directive 2.340(a).

- If a specific known pet is identified as chasing or threatening livestock, the pet owner, resource owner, and animal control must be notified to afford them an opportunity to control the animal prior to removal by WS (WS Directive 2.340(a)).

- Owned dogs captured or killed by WS must be returned to their owners or transferred to animal control authorities immediately (WS Directive 2.340(a)), and the land owner informed of their capture (WS Directive 2.340, WS Directive 2.340(a)).

- Feral dogs (ownerless or homeless wild dogs) captured unintentionally by WS and uninjured will be transferred to animal control authorities or released onsite (WS Directive 2.340(a)). Feral dogs captured unintentionally by WS and injured will be transferred to animal control authorities (WS Directive 2.340(a)). If feral dogs are killed unintentionally by WS, WS will notify animal control authorities (WS Directive 2.340(a)). WS would inform the land owner in accordance with WS Directives 2.340 and WS Directive 2.340(a).

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

  M-44s (sodium cyanide) would be used by WS in accordance with the EPA's use restrictions to reduce risks to dogs (WS Directive 2.415).

- WS' use of M-44s (sodium cyanide) would be restricted in accordance with WS Directive 2.415(c).

- In compliance with WS Directive 2.440,WS personnel would be cautious when working near or around guard dogs.

- Livestock protection collars (LPC) (compound 1080) would be used by WS in accordance with the technical bulletin (WS Directive 2.420).

Issue 3 - Effects of Damage Management Activities on Non-target Animals, Including Threatened and Endangered Species

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

- When appropriate, suppressed firearms would be used to minimize noise impacts.

- If an animal that appears to be a licensed pet is captured; the animal will be handled in accordance with WS Directive 2.450.

- M-44s (sodium cyanide) would be used by WS in accordance with the EPA's use restrictions to reduce risks to non-target animals (WS Directive 2.415).

- WS use of M-44s (sodium cyanide) would be restricted in accordance with WS Directive 2.415(c).

- Livestock protection collars (LPC) (compound 1080) would be used by WS in accordance with the technical bulletin (WS Directive 2.420).

Issue 4 - Effects of Damage Management Activities on Human Health and Safety

- Damage management activities would be conducted away from areas of high human activity. If this is not possible, then activities would be conducted during periods when human activity is low (e.g., early morning) whenever possible.

- All chemicals used by WS would be securely stored and properly monitored to ensure the safety of the public. WS' use of chemicals and training requirements to use those chemicals are outlined in WS Directive 2.401.

- M-44s (sodium cyanide) would be used by WS in accordance with the EPA's use restrictions to reduce risks to human health and safety (WS Directive 2.415).

- WS use of M-44s (sodium cyanide) would be restricted in accordance with WS Directive 2.415(c).

- Livestock protection collars (LPC) (compound 1080) would be used by WS in accordance with the technical bulletin (WS Directive 2.420).

Issue 5 – Humaneness and Animal Welfare Concerns

- WS personnel would be trained in the latest and most humane devices and methods for removing coyotes, dogs and red foxes.

- WS use of all traps, snares (cable devices), and other capture devices would comply with WS Directive 2.450 and 2.450(b).

- WS' use of euthanasia methods would comply with WS Directive 2.505.

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

- WS personnel shall only utilize trained dogs (dogs proficient in the skills necessary to perform specific functions in a manner that is responsive to its handler's commands) in accordance with WS Directive 2.445.

Issue 6 – Effects of Damage Management Activities on the Aesthetic Values of Coyote, Dog and Red Fox

- WS would set capture devices to minimize visibility of captured animals in compliance with WS Directive 2.450.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

This chapter provides the information needed for making an informed selection among the alternatives identified and described in Chapter 3; a selection which not only addresses the need for action identified in Chapter 1 but also addresses the issues identified in Chapter 2. Specifically, this chapter analyzes the environmental consequences of each of the alternatives as those alternatives relate to the issues identified in Chapter 2. Additionally, this chapter compares the environmental consequences of the proposed action / no action alternative to the environmental consequences of the other alternatives.

Environmental consequences can be direct, indirect, and cumulative.

Direct Effects: Caused by the action and occur at the same time and place.

Indirect Effects: These are impacts caused by an action that are later in time or farther removed in distance but are still reasonably foreseeable.

Cumulative Effects: As defined by CEQ (40 CFR 1508.7), these 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.

Irreversible and Irretrievable Commitments of Resources: Other than minor uses of fuels for motor vehicles and other materials, there are no irreversible or irretrievable commitments of resources.

The following resource values in the state are not expected to be significantly impacted by any of the alternatives analyzed as none of the alternatives cause any significant ground disturbance: soils, geology, minerals, water quality/quantity, flood plains, wetlands, critical habitats (areas listed in threatened and endangered species recovery plans), visual resources, air quality, prime and unique farmlands, aquatic resources, timber, and range. Therefore, these resources will not be analyzed.

4.1 Environmental Consequences for Issues Analyzed in Detail

The proposed action / no action alternative 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 Virginia State Agencies.

Issue 1 - Effects of Damage Management Activities on Coyote and Red Fox Populations

The issue of the potential direct and cumulative impacts of conducting the alternatives on the populations of target coyote and red fox populations is analyzed for each alternative below.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

The proposed action / no action alternative would continue the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques, as deemed appropriate using the WS Decision Model, to reduce damage and threats to livestock associated with coyotes and red foxes in Virginia.

The issue of the effects on target species arises from the use of non-lethal and lethal methods to address the need for reducing damage and threats; however, the primary concern would be from the use of lethal methods to address damage.

Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive or unavailable to the species (target species) causing the damage, thereby reducing the presence of those species in the area. Non-lethal methods would be given priority when addressing requests for assistance (WS Directive 2.101). However, non-lethal methods would not necessarily be employed or recommended to resolve every request for assistance if deemed inappropriate by WS' personnel using the WS Decision Model. For example, if those requesting assistance have already used non-lethal methods, WS would not likely recommend or continue to employ those particular methods because their use has already been proven ineffective in adequately resolving the damage or threat. When effective, non-lethal methods would disperse coyotes or red foxes from the area resulting in a reduction in the presence of those animals at the site. However, animals responsible for causing damage or threats are moved to other

areas with minimal impact on those species' populations. WS would not employ or recommend these methods be employed over large geographic areas or at such intensity that essential resources would be unavailable and that long term adverse impacts to animal populations would occur. Non-lethal methods are generally regarded as having minimal impacts on overall populations of wildlife because individuals of those species are unharmed. The use of non-lethal methods would not have adverse population impacts under any of the alternatives.

The lethal removal of coyotes and red foxes would be monitored by comparing the number of each species lethally removed with that species' overall population trend to assure the magnitude of lethal removal is maintained below the level that would cause adverse effects to the viability of species' populations. Population estimates are unavailable for coyote and red fox in Virginia. The potential impacts on coyote and red fox populations from the implementation of the proposed action / no action alternative are analyzed for each species below. No indirect effects were identified for this issue.

Coyote Population Impact Analysis

Originally a western plains species, coyotes began moving eastward around 1900 (Moore and Parker 1992, Parker 1995). Coyotes were first reported in Virginia's Rockingham County in 1965 (Linzey 1998) and can now be found statewide (M. L. Fies, VDGIF, personal communication 2015). Coyotes inhabit a wide range of habitats where they forage on a variety of items including fruit, seeds, vegetation, invertebrates, fish, amphibians, reptiles, birds, and mammals, including livestock (Mastro 2011, Mastro et al. 2012). Most coyotes are members of social groups which share the same territory (Mastro 2011). Territories are typically controlled and maintained by a dominant breeding pair (Gese and Ruff 1997; 1998) and their subordinates (Bekoff and Wells 1986; Gese et al. 1996*a, b*; Camenzind 1978). Coyotes in the eastern U.S. typically live in groups of 2–4 (Caturano 1983) but larger groups of 3–4 adults and 5–7 pups occur (Mastro 2011). The dominant breeding pair produces a single litter each spring (Kennelly and Johns 1976). In western Tennessee, average litter size (based on placental scars) was 3.4 pups while litters in Massachusetts averaged 4.5 pups (n = 16) (Mastro 2011) and litters (based on fetuses) in West Virginia averaged 5.9 pups (n = 9) (Geriann Albers, West Virginia University, personal communication 2014). The average home range (the area an animal occupies, as opposed to its territory which is the area it defends) of a coyote in surrounding states varies drastically (2.2 –43.5 mi^2) (Mastro 2011). The number and density of coyotes on the landscape is primarily a function of food abundance on the landscape (Gier 1968, Clark 1972) mediated by social dominance and territoriality (Knowlton et al. 1999). The population density of coyotes in the greater mid-Atlantic region has been reported as ranging from 0.26 coyotes per square mile (New York) to 3.88 coyotes per square mile (South Carolina) (Schrecengost 2007, Frair et al. 2014).

Surveys of bowhunters' observations of coyotes while afield conducted by the VDGIF since 1997 show an increasing trend (Lafon et al. 1998; Farrar et al. 1999, 2000, 2001, 2002; Lafon et al. 2004; Fies and Norman 2004, 2005; Fies 2006, 2007, 2008, 2009, 2010b, 2011a, 2012a, 2013a, 2014a). Additionally, the VDGIF and other mid-Atlantic state wildlife agencies reported increases in the number of coyotes harvested from 1990 through 2010, suggesting the population is increasing (Mastro 2011). The Commonwealth's coyote population is unknown.

The number of coyotes lethally removed by WS to alleviate damage and threats to livestock and other resources as well as the number harvested by hunters and brokered by fur dealers from 2008 to 2013 is shown in Table 4.1. Although lethal removal of coyotes can occur throughout the year by a landowner without need for a license, many coyotes are lethally removed by individuals with licenses, and therefore reported during an annual hunter harvest survey conducted by the VDGIF. The highest number of coyotes harvested by hunters in the past several years occurred in 2008, when an estimated 24,449 coyotes were harvested (Table 4.1). Survey participants are asked not to report animals trapped. The

average annual hunter harvest from 2008 to 2013 was 22,127 coyotes per year. For the first time in many years the VDGIF conducted an annual survey of licensed trappers to quantify the number of animals harvested during the 2013–2014 trapping season. An estimated 2,898 coyotes were harvested by trappers during that period. The VDGIF also conducts an annual survey of licensed fur dealers (i.e. persons who buy and sell the hide, pelt or fur of fur-bearing animals) to quantify the number of coyote pelts purchased or brokered. These animals may have been harvested by hunters or trappers; however, the majority are harvested by trappers (M. L. Fies, VDGIF, personal communication 2015). From 2008 to 2013, the average annual number of coyote pelts purchased or brokered was 1,046. The total number of coyotes lethally removed by individuals without licenses to hunt other game or by other entities to alleviate damage in the Commonwealth is unknown.

Table 4.1 – Number of coyotes addressed in Virginia from 2008 to 2013.

Year	WS' Lethal Removal[1]			Hunter Harvest[4] /Trapper Harvest[5]	Fur Dealer Transactions[6]
	to manage damage to livestock	to manage damage to other resources[2]	total lethal removal by WS[3]		
2008	455	2	457	24,449	479
2009	384(1)	7	391(1)	17,889	279
2010	304	22	326	No survey conducted	913
2011	487	24	511	23,467	1,636
2012	371	21	392	No survey conducted	1,460
2013	341(1)	32	373(1)	22,705 / 2,898	1,509
AVERAGE ANNUAL	**390(0.3)**	**18**	**408(0.3)**	**22,127**	**1,046**

(#)In both FY 2009 and 2013 WS destroyed a single coyote den
[1]Data reported by federal fiscal year, includes non-target lethal removal
[2]This lethal removal is analyzed in separate analyses pursuant to the NEPA
[3]WS' lethal removal to manage damage and threats to livestock and other resources
[4]Data reported by state fiscal year, Jagnow et al. 2009, VDGIF 2010, VDGIF 2012, Kidd et al. 2014*a*.
[5]Data reported by state fiscal year, Kidd et al. 2014*b*.
[6]Data reported by state fiscal year, Fies 2010a, Fies 2011b, Fies 2012b, Fies 2013b, Fies 2014b.

Based on previous requests for assistance and in anticipation of an increase in the number of requests for assistance, WS could lethally remove up to 1,000 coyotes annually under the proposed action / no action alternative to manage damage or threats of damage to livestock.

The lethal removal of up to 1,000 coyotes would represent 4.5% of the average number of coyotes harvested annually by hunters (22,127) and 4.3% of the total known average annual harvest (23,173) [i.e. average number of coyotes purchased or brokered by fur dealers (and harvested primarily by trappers) plus the average number of coyotes harvested by hunters]. An additional 500 coyotes could be lethally removed by WS' in the Commonwealth to manage damage and threats to other resources under a separate analysis. Therefore WS could lethally remove up to 1,500 coyotes annually to protect all resources. This would represent 6.7% of the average number of coyotes harvested annually by hunters in the Commonwealth and 6.5% of the total known average annual harvest. As stated in Appendix B, WS could use large gas cartridges to fumigate coyote dens where damage to livestock is occurring. Although coyote dens may have more than one entrance, coyotes are territorial and therefore it is unlikely that more than a single social group would be associated with any given den site. Studies or observations of adult coyotes at den sites (Till and Knowlton 1983, Coolahan 1990) indicate that fumigation of a den would be expected to only lethally remove pups. Based on an average litter size of 6 pups (see average litter size discussion above), fumigation of a single coyote den would result in the lethal removal of 6 pups. Given the increasing number of observations of coyotes by bowhunters during the bowhunter survey and the limited lethal removal proposed by WS to alleviate damage and threats to livestock when compared to the

overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on coyote populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal occurring within Virginia and could be considered of low magnitude when compared to the number of coyotes being harvested and lethally removed in Virginia. Harvest and lethal removal of coyotes can only occur at the discretion of the VDGIF. The VDGIF ensures harvest and lethal removal occurs to achieve desired population objectives. WS would report the number of coyotes lethally removed annually, which would ensure cumulative impacts would be considered as part of VDGIF population management objectives for coyotes.

Red Fox Population Impact Analysis

Although native to North America, red foxes were largely absent from Virginia and other areas of the mid-Atlantic and southeastern U.S. at the time of European settlement (Linzey 1998, Statham et al. 2012, Frey 2013). By the 1800s red foxes could be found statewide (Linzey 1998, Statham et al. 2012). Although European red foxes were introduced, genetic analysis indicates that red foxes in the region originated from a natural range expansion of native North American red foxes, not European stock as was previously believed (Statham et al. 2012, Frey 2013). Red foxes prefer open habitat (e.g. agricultural areas, grasslands, marshes) mixed with wooded areas and brushy vegetation (Voigt 1987) but they will also occupy forests as well as urban areas (Cypher 2003). They forage on a variety of items including fruit, seeds, vegetation, invertebrates, fish, amphibians, reptiles, birds, and mammals, including livestock and carrion (Voigt 1987, Larivière and Pasitschniak-Arts 1996, Cypher 2003). During the breeding season, most red foxes in the eastern U.S. live as a breeding pair which occupies the same territory along with their pups (Voigt 1987, Larivière and Pasitschniak-Arts 1996, Cypher 2003). Occasionally, the mated pair may also share their territory with one or more additional females (Voigt 1987, Larivière and Pasitschniak-Arts 1996, Cypher 2003). Females produce a single litter each spring (Voigt 1987, Larivière and Pasitschniak-Arts 1996, Cypher 2003). Average litter size (based on embryos and placental scars) was 5.3 pups (n = 95) in New York (Sheldon 1949) while litters in Michigan averaged 4.9 pups (n = 210) (Switzenberg 1950) or 5.1 pups (n = 1,809) (Schofield 1958) and litters (based on fetuses) in Indiana averaged 6.8 pups (n = 30) (Hoffman and Kirkpatrick 1954). The average home range (the area an animal occupies, as opposed to its territory, which is the area it defends) of a red fox in the eastern U.S. is variable (1.9–7.6 mi^2) (Major and Sherburne 1987, Harrison et al. 1989, Gooselink et al. 2003). The population density of red foxes has been estimated as ranging from 2.6 red fox per square mile (southern Ontario, Canada) to three times that many in Europe (Voigt 1987). No average litter sizes, home ranges or densities are available for red foxes in the mid-Atlantic.

Surveys of bowhunter observations of red foxes while afield conducted by the VDGIF since 1997 have indicated a stable trend (Lafon et al. 1998; Farrar et al. 1999, 2000, 2001, 2002; Lafon et al. 2004; Fies and Norman 2004, 2005; Fies 2006, 2007, 2008, 2009, 2010b, 2011a, 2012a, 2013a, 2014a).

The number of red foxes lethally removed by WS to alleviate damage and threats to livestock and other resources as well as the number harvested by hunters and brokered by fur dealers from 2008 to 2013 is shown in Table 4.2. Lethal removal of red foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee without need for a license, or during hunting and trapping seasons. Since 2008, the highest number of red foxes harvested by hunters occurred in 2008 when an estimated 10,986 red foxes were harvested (Table 4.2). Survey participants are asked not to report animals trapped. The average annual hunter harvest from 2008 to 2013 was 8,344 red foxes per year. For the first time in many years the VDGIF conducted an annual survey of licensed trappers to quantify the number of animals harvested during the 2013–2014 trapping season. An estimated 5,556 red foxes were harvested by trappers during that period. The VDGIF also conducts an annual survey of licensed fur dealers (i.e. persons who buy and sell the hide, pelt or fur of fur-bearing animals) to quantify the number of red fox pelts purchased or brokered. These animals may have been harvested by hunters or trappers,

however, the majority are harvested by trappers (M. L. Fies, VDGIF, personal communication 2015). From 2008 to 2013, the average annual number of red fox pelts purchased or brokered was 2,996. The total number of red foxes lethally removed by other entities to alleviate damage in the Commonwealth is unknown.

Table 4.2 – Number of red foxes addressed in Virginia from 2008 to 2013.

Year	WS' Lethal Removal[1]			Hunter Harvest[4] /Trapper Harvest[5]	Fur Dealer Transactions[6]
	to manage damage to livestock	to manage damage to other resources[2]	total lethal removal by WS[3]		
2008	140	113(7)	253(7)	10,986	2,230
2009	77	77(3)	154(3)	9,690	1,871
2010	61	85(17)	146(17)	No survey conducted	2,839
2011	80	115(8)	195(8)	8,776	3,424
2012	61(1)	97(7)	158(8)	No survey conducted	3,175
2013	38(1)	113(2)	170(3)	3,922 / 5,556	4,438
AVERAGE ANNUAL	**76(0.3)**	**100(7.3)**	**179(7.6)**	**8,343**	**2,996**

(#) Number of red fox dens destroyed by WS
[1]Data reported by federal fiscal year, includes non-target lethal removal
[2]This lethal removal is analyzed in separate analyses pursuant to the NEPA
[3]WS' lethal removal to manage damage and threats to livestock and other resources
[4]Data reported by state fiscal year, Jagnow et al. 2009, VDGIF 2010, VDGIF 2012, Kidd et al. 2014*a*.
[5]Data reported by state fiscal year, Kidd et al. 2014*b*.
[6]Data reported by state fiscal year, Fies 2010*a*, Fies 2011*b*, Fies 2012*b*, Fies 2013*b*, Fies 2014*b*.

Based on previous requests for assistance and in anticipation of an increase in the number of requests for assistance, WS could lethally remove up to 300 red foxes annually under the proposed action / no action alternative to manage damage or threats of damage to livestock.

The lethal removal of up to 300 red foxes would represent 3.59% of the average number of red foxes harvested annually by hunters (8,344) and 2.64% of the total known average annual harvest (11,340) [i.e. average number of red fox purchased or brokered by fur dealers (and harvested primarily by trappers) plus the average number of red fox harvested by hunters]. An additional 300 red foxes could be lethally removed by WS to manage damage and threats to other resources under a separate analysis. Therefore, WS could lethally remove up to 600 red foxes annually. This would represent 7.19% of the average number of red foxes harvested annually by hunters and 5.29% of the total known average annual harvest. As stated in Appendix B, WS could use large gas cartridges to fumigate red fox dens where damage to livestock is occurring. Although red fox dens often have more than one entrance, red foxes are territorial and therefore it is unlikely that more than a single breeding pair, their pups and possibly one additional female could be associated with any given den site. Based on an average litter size of 5 pups (see average litter size discussion above), and the fact that only the mother generally occupies the den when pups are present (Lloyd 1983), fumigation of a single den site would be expected to lethally remove 6 individuals (5 pups and 1 breeding female). Given the stable number of observations of red foxes during the bowhunter survey and the limited lethal removal proposed by WS to alleviate damage and threats to livestock when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on red fox populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal occurring within Virginia and could be considered of low magnitude when compared to the number of red foxes being harvested and lethally removed in Virginia. Harvest and lethal removal of red fox can only occur at the discretion of the VDGIF. The VDGIF ensures harvest and lethal removal occurs to achieve desired population objectives. WS would report red fox lethally removed annually, which would ensure

cumulative impacts would be considered as part of VDGIF population management objectives for red fox.

Summary Coyote and Red Fox Population Impact Analysis

Evaluation of WS' proposed action / no action alternative indicated that program activities would have no direct, or cumulative adverse effects on coyote or red fox populations. WS' actions would be occurring simultaneously, over time, with other natural processes and human-generated changes that are currently taking place. Those activities include, but are not limited to: natural mortality of wildlife, naturally induced changes to wildlife habitat, natural ecological population cycles, human-induced mortality, and human-induced changes to wildlife habitat.

All these factors play a role in the dynamics of wildlife populations. WS' actions taken to minimize or eliminate damage would be constrained in scope, duration and intensity, for the purpose of minimizing or avoiding impacts. WS' SOPs are designed to reduce the potential negative effects of WS' actions by identifying and responding to both anticipated and unanticipated changes in wildlife populations and the environment. WS continually monitors, evaluates and makes modifications as necessary to methods or strategy when providing direct operational assistance, to not only reduce damage but also to identify and minimize potentially harmful effects. This process allows WS to take into consideration other influences in the environment in order to avoid adverse cumulative impacts.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs or red foxes with technical assistance only.

Despite no direct involvement by WS in resolving damage and threats to livestock those persons experiencing damage caused by coyotes, dogs or red foxes could continue to alleviate damage by employing both non-lethal and lethal methods. Appendix B contains a thorough discussion of the methods available for use in managing damage and threats to livestock associated with coyotes, dogs or red foxes. With the exception of Livestock Protection Collars (sodium fluoroacetate) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative.

The number of coyotes or red foxes lethally removed under this alternative would likely be similar to the other alternatives. Although, two methods (LPCs and M-44s) would not be available under this alternative, those animals removed under Alternative 1 could be removed with other methods by other entities under this alternative. The lethal take of coyotes can occur at any time and lethal take of foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee, or during hunting and trapping seasons. WS' assistance with removing coyotes or red foxes causing damage or threats of damage to livestock would not be additive to the environmental status quo.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action. Therefore, coyote or red fox populations in the Commonwealth would not be directly impacted by WS from a program implementing technical assistance only.

With the oversight of the VDGIF, it is unlikely that coyote or red fox populations would be directly or cumulatively adversely impacted by the implementation of this alternative. Management actions could be

undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by other entities such as the VDGIF. If direct operational assistance is not provided by WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and threats could lead to the inappropriate use of legal methods or the use of illegal methods which could lead to unnecessary killing of wildlife. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not conduct technical or direct operational assistance to reduce threats or alleviate damage to livestock associated with coyotes, dogs or red foxes. WS would not be involved with any aspect of managing damage to livestock associated with coyotes, dogs or red foxes. All requests for assistance received by WS to resolve damage caused by coyotes, dogs or red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. Similar to Alternative 2, with the exception of Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative.

Lethal removal of coyotes and red foxes could continue to occur since the lethal removal of coyotes can occur at any time lethal removal of foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee, or during hunting and trapping seasons. The number of coyotes and red foxes lethally removed under this alternative and any direct or cumulative population impacts would likely be similar to the other alternatives.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

Management actions could be undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by other entities such as the VDGIF. If direct operational assistance and technical assistance is not provided by WS or other entities, it is possible that a lack of technical knowledge could lead to the misidentification and false targeting of predator(s) responsible for damage. It is also possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. This may occur if those persons or organizations providing technical assistance have less technical knowledge and experience managing wildlife damage than WS. Illegal, unsafe, and environmentally unfriendly actions could lead to unnecessary killing of wildlife. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Issue 2 - Effects of Damage Management Activities on Dogs

The issue of the potential impacts of conducting the alternatives on dogs is analyzed for each alternative below. This concern includes dogs causing damage as well as dogs not causing damage that could be

captured or killed by methods used to resolve damage to livestock. Dogs have been owned and valued as pets, working and hunting companions since the Commonwealth's days as a British colony (Breig 2004, Hood 2006). However, dogs have been recognized as a threat to livestock for just as long (Breig 2004). A 1769 petition noted the, "great injury and loss that we sustain in our flocks of sheep, by the dogs which are suffered to run at large…'tis notorious that the dogs are worse than wolves" (Breig 2004).

Dogs are classified as companion animals in the Code of Virginia and are managed by local law enforcement and animal control authorities. Dogs may be 1) owned and under the owner's direct control, 2) owned but free-ranging (not under the owner's direct control), 3) feral (ownerless or homeless wild dog), 4) owned hybrid (animals that are the progeny of a domestic dog and any other species of the Canidae family) under the owner's direct control, 5) owned but free-ranging hybrid or 6) feral hybrid. The Code of Virginia recognizes the potential damage dog and hybrid canines can cause. Dogs or hybrid canines, "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock", can be seized or lethally removed (§ 3.2-6552, § 3.2-6583).

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

The proposed action / no action alternative would continue the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques, as deemed appropriate using the WS Decision Model, to reduce damage and threats to livestock associated with dogs in Virginia. The issue arises from the use of non-lethal and lethal methods to address the need for reducing damage and threats to livestock associated with coyotes, dogs or red foxes; however, the primary concern would be from the use of lethal methods to address damage.

Standard Operating Procedures (SOPs) for damage management in Virginia discussed in Chapter 3 ensure risks to dogs (those that do not cause damage) would be reduced or prevented under the proposed action / no action alternative. Pertinent SOPs include not only the WS Decision Model (WS Directive 2.201), an evaluation process for the appropriateness of methods (WS Directive 2.101) and the use of integrated management (WS Directive 2.105) but also several other SOPs including the following. WS would conduct dog management in coordination with state and local authorities with jurisdiction over dog control in accordance with WS Directive 2.340. In urban areas, WS will refer requests for assistance to the local animal control or law enforcement authority in accordance with WS Directive 2.340(a). If a specific known pet is identified as chasing or threatening livestock, the pet owner, resource owner, and animal control must be notified to afford them an opportunity to control the animal prior to removal by WS (WS Directive 2.340(a)). Direct operational assistance would only be conducted by WS after a document listing all the methods the property owner or manager will allow to be used was signed by WS and those requesting assistance. This document may advise those persons requesting assistance to contact and inform those persons utilizing or adjoining the property they own and/or manage of control activities. WS verbally advises those persons requesting assistance to contact and inform persons utilizing or adjoining the property they own and/or manage of control activities. Owned dogs captured or killed by WS must be returned to their owners or transferred to animal control authorities immediately (WS Directive 2.340(a)), and the land owner informed of their capture (WS Directive 2.340, WS Directive 2.340(a)). Feral dogs captured unintentionally by WS and uninjured will be transferred to animal control authorities or released onsite (WS Directive 2.340(a)). Feral dogs captured unintentionally by WS and injured will be transferred to animal control authorities (WS Directive 2.340(a)). If feral dogs are killed unintentionally by WS, WS will notify animal control authorities (WS Directive 2.340(a)) and inform the land owner in accordance with WS Directives 2.340 and WS Directive 2.340(a). WS personnel would be cautious when working near or around guard dogs to minimize potential hazards from management methods in compliance with WS Directive 2.440.

Free-ranging and feral dogs or hybrids have been documented in all 50 states (Bergman et al. 2009). They forage on a variety of items including; carrion, crops, fruit, garbage, livestock, livestock feed, seeds, vegetation and wildlife including threatened and endangered species (Scott and Causey 1973, Green and Gipson 1994, Bergman et al. 2009, Hughes and Macdonald 2013). These animals may also be fed directly by humans (Scott and Causey 1973). When food resources are available, these animals can live independently of humans in stable groups composed of multiple breeding individuals of both sexes (Cafazzo et al. 2014). Groups of 2 to 42 individuals have been observed (Scott and Causey 1973, Cafazzo et al. 2014) but these animals may also be solitary (Scott and Causey 1973). In Alabama, groups occupied areas ranging in size from 0.69 to 1.64 square miles (Scott and Causey 1973). Female dogs have the ability to breed year round (approximately every 7 months) while the frequency and ability of hybrids to breed is largely a function of ancestry (Silver and Silver 1969, Adams et al. 2003, Root Kustritz 2006, Ghert et al. 2010). Therefore, the ability of a population to sustain itself is largely a function the availability of resources, mortality (due to starvation, disease, adverse weather or humans), removal by private individuals, local law enforcement and animal control authorities as well as the number of animals being introduced into the population via reproduction in the wild or abandonment (Scott and Causey 1973, Pal 2001, Amaku et al. 2010).

Non-Lethal Methods

Non-lethal methods have the potential to affect dogs primarily though physical exclusion, frightening devices or deterrents (see Appendix B). Any exclusionary device erected to prevent predator access to livestock would inhibit the movement of dogs. Any potential impacts to dogs from exclusionary devices are expected to be insignificant. The use of frightening devices or deterrents may also disperse dogs from the immediate area where they are employed or frighten dogs restrained or confined in the immediate area. However, the potential impacts to dogs from frightening devices or deterrents are expected to be temporary.

Lethal Methods

In cases where shooting were selected as an appropriate method, identification of an individual target would occur prior to application, eliminating risks to non-targets. WS' recommendation that shooting be used would not increase risks to non-targets. Shooting would essentially be selective for target animals and the unintentional lethal removal of non-targets would not likely increase based on WS' recommendation of the method. Dogs captured during the implementation of non-lethal capture methods can be released prior to euthanasia which occurs subsequent to live-capture. Owned dogs captured by WS must be returned to their owners or transferred to animal control authorities immediately, feral dogs captured unintentionally by WS and uninjured will be transferred to animal control authorities or released onsite, and feral dogs captured unintentionally by WS and injured will be transferred to animal control authorities (WS Directive 2.340(a)). Therefore, no adverse effects to dogs would occur from the use of euthanasia methods by WS under this alternative. Similarly, WS' recommendation of euthanasia methods would not increase risks to dogs because these methods are selective for target individuals and the unintentional euthanasia of non-targets would not likely increase based on WS' recommendation of the method.

Snare (cable device) - Under the proposed action / no action alternative, WS would only place snares on a given property in response to a request for assistance after the property owner or manager has signed a document agreeing to allow snares to be used on property they own and/or manage. WS would use snares in compliance with applicable federal, state and local laws and regulations (WS Directive 2.210) as well as WS Directives to minimize risks to non-targets. These include but are not limited to § 29.1-521 of the Code of Virginia, WS Directives 2.450 and 2.340(a). Dogs captured in snares and accompanied by

humans can be released unharmed. WS' recommendation of the use of snares as a method is not likely to increase the risk to dogs.

M-44s (sodium cyanide) - A common concern regarding the use of M-44s is the potential risk to dogs. Under the proposed action / no action alternative, WS would only place M-44s on a given property in response for a request for assistance after the property owner or manager has signed a document agreeing to allow M-44s to be used on property they own and/or manage. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the property of control activities. M-44s would be used by WS in accordance with the EPA's use restrictions (WS Directive 2.415) as well as WS Directive 2.415(c) to minimize risks to non-targets.

Livestock protection collars (sodium fluoroacetate) - Under the proposed action / no action alternative, WS would only place livestock protection collars (LPCs) on a given property in response to a request for assistance after the property owner or manager has signed a document agreeing to allow LPCs to be used on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the property of control activities. LPCs would be used by WS in accordance with the technical bulletin (WS Directive 2.420) to minimize risks to non-targets.

Dog Impact Analysis

The analysis to determine the impacts on dogs from the use of both lethal and non-lethal methods is based on a measure of the number of individuals captured and injured or killed. Methods would only be used by WS at the request of persons seeking assistance. Any activities conducted by WS under the alternatives addressed would occur along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, local law enforcement and animal control authorities.

WS personnel are trained and experienced in the identification of livestock predation damage, the identification of animals responsible for the damage, the identification of individual animals, and in the selection of and implementation of methods which are as species-specific as possible thus reducing the risks to dogs. Management actions are directed towards specific animals or groups of animals responsible for causing damage or posing threats. WS would coordinate with state and local authorities with jurisdiction over dog control in accordance with WS Directive 2.340. In urban areas, WS would refer requests for assistance to the local animal control or law enforcement authority in accordance with WS Directive 2.340(a). Non-lethal methods are given priority when addressing requests for assistance (WS Directive 2.101). Owned dogs captured by WS must be returned to their owners or transferred to animal control authorities immediately. Feral dogs captured unintentionally by WS and uninjured will be transferred to animal control authorities or released onsite, and feral dogs captured unintentionally by WS and injured will be transferred to animal control authorities (WS Directive 2.340(a)).

The number of dogs in the Commonwealth was estimated to be 1,555,000 animals in 2005 (Bartlett et al. 2005). The number of dogs addressed by WS to alleviate damage and threats to livestock and other resources as well as the number addressed by Virginia rescue agencies, city facilities and county facilities from 2008 to 2013 is shown in Table 4.3. Dogs or hybrid canines, "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock", can be seized or lethally removed (§ 3.2-6552, § 3.2-6583). The number of dogs seized or lethally removed by local law enforcement, animal control authorities or private entities because they are causing damage to livestock is unknown.

Table 4.3 – Number of dogs and dog hybrids captured by WS compared to dogs and dog hybrids received by rescue agencies, city facilities and county facilities in Virginia from 2008 to 2013.

Year	captured by WS[1]									received by Virginia rescue agencies, city facilities and county facilities[3]		
	Transferred custody			Freed/ Released			Lethal removal					
	During activities to manage damage to livestock	During activities to manage damage to other resources[2]	Total	During activities to manage damage to livestock	During activities to manage damage to other resources[2]	Total	During activities to manage damage to livestock	During activities to manage damage to other resources[2]	Total	Received	Died in facility	Euthanized
2008	0	(1)	(1)	2(4)	0	2(4)	13(1)	0	13(1)	141,205	1,055	39,672
2009	2	1	3	3(8)	0	3(8)	6	0	6	122,266	808	34,649
2010	0	0	0	(5)	(1)	(6)	5	(1)	5(1)	132,661	984	34,493
2011	0	0	0	1(3)	0	1(3)	5	0	5	125,792	903	31,071
2012	0	1	1	1(1)	0	1(1)	9	0	9	130,134	914	27,460
2013	0	1	1	(2)	(1)	(3)	1	0	1	125,817	1,009	22,049
AVERAGE ANNUAL	**0.3**	**0.5 (0.1)**	**0.8 (0.1)**	**1.1 (3.8)**	**(0.3)**	**1.1 (4.1)**	**6.5 (0.1)**	**(0.1)**	**6.5 (0.3)**	**129,645**	**945**	**31,565**

(#) Individual dogs addressed unintentionally, includes non-target
{#} Hybrid canines
[1]Data reported by federal fiscal year
[2]This lethal removal is analyzed in separate analyses pursuant to the NEPA
[3]Data reported by calendar year (VDACS 2015)

During activities to protect livestock from 2008 to 2013, WS captured and either freed, released, returned to their owner or transferred to animal control authorities an average of 5.3 dogs per year. No dogs sustained serious injuries during this time. During this same period WS lethally took an average of 6.5 dogs per year while conducting activities to protect livestock. Only one dog was unintentionally killed during this six year period during activities to protect livestock. Documentation and reporting of injuries or death of dogs from WS's activities is required (WS Directive 2.340(a)).

Based on previous requests for assistance, WS could lethally remove up to 25 dogs annually under the proposed action / no action alternative to manage damage or threats of damage to livestock. The lethal removal of up to 25 dogs would represent 0.07% of the average number of dogs euthanized (31,565 dogs) and 2.64% of the dogs that died (946 dogs) while in the custody of Virginia's rescue agencies and city and county facilities on an annual basis from 2008 to 2013. An additional 25 dogs could be lethally removed by WS in the Commonwealth to manage damage and threats to other resources under a separate analysis. Therefore WS could lethally remove up to 50 dogs annually. This lethal removal would represent 0.15% of the average number of dogs euthanized and 5.28% of the dogs that died while in the custody of Virginia's rescue agencies, city and county facilities on an annual basis from 2008 to 2013. WS' intentional lethal removal would target specific dogs that are damaging livestock. No significant direct or cumulative effects on dog populations are expected from implementation of the proposed action / no action alternative. No indirect effects were identified.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs or red foxes with technical assistance only.

Despite no direct involvement by WS in resolving damage and threats to livestock, those persons experiencing damage caused by coyotes, dogs or red foxes could continue to alleviate damage by employing both non-lethal and lethal methods. Appendix B contains a thorough discussion of the

methods available for use in managing damage and threats to livestock associated with coyotes, dogs or red foxes. With the exception of Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative. The number of dogs lethally removed under this alternative would likely be similar to the other alternatives because the lethal removal of dogs or hybrid canines can occur when they are "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock"(§ 3.2-6552, § 3.2-6583).

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

It is unlikely that dogs would be directly or cumulatively impacted by the implementation of this alternative. Management actions could be undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by local law enforcement or animal control authorities. If direct operational assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats could lead to the in appropriate use of lethal methods or the use of illegal methods which could lead to unnecessary killing of other animals. In the past, people have resorted to the illegal use of chemicals and methods to alleviate damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not conduct technical or direct operational assistance to reduce threats or alleviate damage to livestock associated with coyotes, dogs or red foxes. WS would not be involved with any aspect of managing damage to livestock associated with coyotes, dogs or red foxes. All requests for assistance received by WS to resolve damage caused by coyotes, dogs or red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats to livestock associated with dogs, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. Similar to Alternative 2, with the exception of Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide), all methods listed in the Appendix B could be available under this alternative. Lethal removal of coyotes and red foxes could continue to occur because the lethal removal of dogs or hybrid canines can occur when they are "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock"(§ 3.2-6552, § 3.2-6583). The number of dogs lethally removed under this alternative would likely be similar to the other alternatives as would any direct or cumulative impacts.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action. Management actions could be undertaken by a property owner or manager, provided by private nuisance wildlife control agents, provided by volunteer services of private individuals or organizations, or provided by local law enforcement or animal control authorities.

Potential impacts to dogs would be variable under this alternative. If direct operational assistance and technical assistance is not provided by WS or other entities, it is possible that a lack of technical knowledge could lead to the misidentification and false targeting of predator(s) responsible for damage. It is also possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. This may occur if those persons or organizations providing technical assistance have less technical knowledge and experience managing wildlife damage than WS. Illegal, unsafe, and environmentally unfriendly actions could lead to unnecessary killing of animals. In the past, people have resorted to the illegal use of chemicals and methods to alleviate damage issues (White et al. 1989, USFWS 2001, FDA 2003). However, if appropriate direct operational assistance and technical assistance was provided by persons knowledgeable and experienced in managing wildlife damage, the risks would be similar to Alternative 2.

Issue 3 - Effects of Damage Management Activities on Non-target Animals, Including Threatened and Endangered Species

As discussed previously, a concern is often raised about the potential impacts to non-target livestock and wildlife populations, including threatened and endangered species, from the use of methods to resolve damage to livestock associated with coyotes, dogs or red foxes. The potential effects are analyzed below.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

The potential adverse effects to non-targets occur from the employment of methods to address damage to livestock associated with coyotes, dogs or red foxes. Under the proposed action / no action alternative, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance. The use of non-lethal methods as part of an integrated direct operational assistance program would be similar to those risks to non-targets discussed in the other alternatives.

Standard Operating Procedures (SOPs) for addressing damage to livestock associated with coyotes, dogs or red foxes in Virginia discussed in Chapter 3 ensure risks to non-target animals, including threatened and endangered species, would be reduced or prevented under the proposed action / no action alternative. Pertinent SOPs include not only the WS Decision Model (WS Directive 2.201), an evaluation process for the appropriateness of methods (WS Directive 2.101) and the use of integrated management (WS Directive 2.105) but also several other SOPs including the following. WS personnel are trained and experienced in the identification of livestock predation management, the identification of animals responsible for the damage, the identification of individual animals, and in the selection of and implementation of methods which are as species-specific as possible thus reducing the risks to non-target animals including threatened and endangered species. Management actions are directed towards specific animals or groups of animals responsible for causing damage or posing threats. WS consults with the USFWS or the NMFS and the VDGIF to determine the potential risks to federally and state listed threatened and endangered species in accordance with the ESA and Commonwealth laws. Non-lethal methods are given priority when addressing requests for assistance (WS Directive 2.101). Non-target animals captured in traps are released unless it is determined that the animal would not survive and or that the animal cannot be safely released.

Non-Lethal Methods

Non-lethal methods have the potential to cause adverse effects to non-targets primarily though physical exclusion, frightening devices or deterrents (see Appendix B). Any exclusionary device erected to prevent access to livestock could also potentially exclude non-target species; therefore adversely

impacting that species. The use of frightening devices or deterrents may also disperse non-target species from the immediate area where they are employed. However, the potential impacts to non-targets, like the impacts to target species, are expected to be temporary. WS would not employ or recommend these methods be employed over large geographic areas or at such intensity that essential resources would be unavailable and that long term adverse impacts to non-target populations would occur.

Other non-lethal methods available for use under any of the alternatives are live-capture traps (see Appendix B). WS would use and recommend the use of target-specific attractants and place them or recommend they be placed in areas where target species are active to reduce the risk of capturing non-targets. WS would monitor or recommend traps be monitored frequently so non-target species can be released unharmed. Non-lethal methods are generally regarded has having minimal impacts on populations because individuals are unharmed. Therefore, non-lethal methods would not have any adverse impacts on non-target populations of wildlife including threatened and endangered species under this alternative. Non-lethal methods would be available under all the alternatives analyzed.

Eagles may occur in or near areas where damage management activities are conducted to protect livestock from damage from coyotes, dogs or red foxes. Routine activities conducted by WS' personnel under the proposed action / no action alternative could occur in areas where eagles are present, which could disrupt the current behavior of an eagle or eagles that are nearby during those activities. As discussed previously, "*take*" as defined by the Bald and Golden Eagle Protection Act, includes those actions that "*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.

WS has reviewed those methods available under the proposed action / no action alternative and the use patterns of those methods. The routine measures that WS conducts would not meet the definition of disturb requiring a permit for the take of eagles. The USFWS states, *"Eagles are unlikely to be disturbed by routine use of roads, homes, or other facilities where such use was present before an eagle pair nesting in a given area. For instance, if eagles build a nest near your existing home, cabin, or place of business you do not need a permit."* (USFWS 2012). Therefore, activities that are species specific and are not of a duration and intensity that would result in disturbance as defined by the Act would not result in non-purposeful take (e.g. unintentional disturbance of an eagle). Activities, such as walking to a site, discharging a firearm, or riding an ATV along a trail, generally represent short-term disturbances to sites where those activities take place. WS would conduct activities that are located near eagle nests using the National Bald Eagle Management Guidelines (USFWS 2007). The categories that encompass most of these activities are Category D (off-road vehicle use), Category F (non-motorized recreation and human entry), and Category H (blasting and other loud, intermittent noises). These categories generally call for a buffer of 330 to 660 feet for category D and F, and a ½-mile buffer for category H. WS would take active measures to avoid disturbance of bald eagle nests by following the National Bald Eagle Management Guidelines. However, other routine activities conducted by WS do not meet the definition of "*disturb*" as defined under 50 CFR 22.3. Those methods and activities would not cause injuries to eagles and would not substantially interfere with the normal breeding, feeding, or sheltering behavior of eagles.

Lethal Methods

In cases where shooting was selected as an appropriate method, identification of an individual target would occur prior to application, eliminating risks to non-targets. Additionally, suppressed firearms would be used when appropriate to minimize noise impacts to non-targets. WS' recommendation that shooting be used would not increase risks to non-targets. Shooting would be selective for target species and the unintentional lethal removal of non-targets would not likely increase based on WS' recommendation of the method. Non-target species captured during the implementation of non-lethal

capture methods can usually be released prior to euthanasia which occurs subsequent to live-capture. Therefore, no adverse effects to non-targets would occur from the use of euthanasia methods by WS under this alternative. Similarly, WS' recommendation of euthanasia methods would not increase risks to non-targets because these methods are selective for target species and the unintentional euthanasia of non-targets would not likely increase based on WS' recommendation of the method. All of the lethal methods listed in Appendix B could be available under this alternative although not all methods would be available for direct implementation by all persons. Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide) are only available for use by WS.

As previously mentioned, eagles may occur in or near areas where management activities are conducted to protect livestock from damage from coyotes, dogs or red foxes under the proposed action / no action alternative. Non-purposeful lethal removal of a bald or golden eagle or their nests is considered a "*take*" as defined by the Bald and Golden Eagle Protection Act. WS has reviewed those methods available under the proposed action / no action alternative and the use patterns of those methods. WS determined that the SOPs that WS uses while conducting damage management activities reduces the likelihood that eagles would be lethally removed (e.g., prohibiting placement of M-44s within 30 feet and placement of a snare within 50 feet of a livestock carcass which may attract eagles). The number of bald eagles observed in the Eastern U.S. along routes surveyed during the Breeding Bird Survey has shown an increasing trend estimated at 8.6% since 1966 and 13.0% from 2002–2012 (Sauer et al. 2014). The number of both bald and golden eagles observed in the Commonwealth during the Christmas Bird Count has shown a dramatic increasing trend since 1966 (National Audubon Society 2010). WS recognizes that the potential exists for eagles to be non-purposefully lethally removed and is currently developing an eagle conservation plan with advanced conservation practices to address potential risks to eagles which may occur unintentionally.

Snare (cable device)- Under the proposed action / no action alternative, WS would only place snares on a given property in response for a request for assistance after the property owner or manager has signed a document agreeing to allow snares be used on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the property of control activities. WS would use snares in compliance with applicable federal, state and local laws and regulations (WS Directive 2.210) as well as WS Directives to minimize risks to non-targets. These include but are not limited to § 29.1-521 of the Code of Virginia, 4VAC 15-40-221 and 4VAC 14-40-220 of the Virginia Administrative Code, WS Directive 2.450 and 2.450(b). WS' recommendation of the use of snares as a method is not likely to increase the risk to non-targets.

M-44s (sodium cyanide) - A common concern regarding the use of M-44s is the potential risk to non-target livestock and wildlife populations including threatened and endangered species. M-44s would be used by WS in accordance with the EPA's use restrictions (WS Directive 2.415) as well as WS Directive 2.415(c) to minimize risks to non-targets.

Livestock protection collars (sodium fluoroacetate)- A common concern regarding the use of livestock protection collars (LPCs) is the potential risk to non-target livestock and wildlife populations including threatened and endangered species. Under the proposed action / no action alternative, WS would only place LPCs on a given property in response for a request for assistance after the property owner or manager has signed a document agreeing to allow LPCs to be used on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the

property of control activities. LPCs would be used by WS in accordance with the technical bulletin (WS Directive 2.420) to minimize risks to non-targets.

Non-Target Animal Impact Analysis

The analysis to determine the impacts on non-targets from the use of both lethal and non-lethal methods is based on a measure of the number of individuals captured or killed. Methods would only be used by WS at the request of persons seeking assistance. Any activities conducted by WS under the alternatives addressed would occur along with other natural process and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, local law enforcement and animal control authorities. The number of individuals of non-target species lethally removed or freed during WS damage management activities to protect livestock in Virginia from FY 2008 to FY 2013 is shown in Table 4.4. WS lethal removal is shown in comparison to cumulative hunter/trapper harvest and fur dealer transactions (for species which are harvestable and for which harvest information is available) from state fiscal year 2008 to 2013. Those species lethally removed unintentionally by WS during damage management activities to protect livestock are common throughout Virginia and not considered to be of low density. WS' unintentional lethal removal of animals that could occur as part of damage management activities to protect livestock is limited and is not expected to have any impact on local or statewide populations. Of those species shown in Table 4.4, only black vultures (*Coragyps atratus*), common ravens (*Corvus corax*), feral cats (*Felis domesticus*), red-tailed hawks (*Buteo jamaicensis*) and turkey vultures (*Cathartes aura*) do not have annual hunting or trapping seasons. The total number of animals harvested by individuals without licenses to hunt other game or by other entities to alleviate damage is unknown. The species of animals lethally removed unintentionally in the past by WS is representative of animals that could be lethally removed by WS under the proposed action / no action alternative. Additionally, other species could be lethally removed unintentionally during damage management activities to protect livestock. However, the lethal removal of those species would occur infrequently and not at levels that would cause significant adverse effects to those species' populations.

Table 4.4 – Species and number of individual animals unintentionally lethally removed by WS during WS' damage management activities to protect livestock in Virginia compared to total number of individual animals lethally removed both unintentionally and intentionally by WS during WS' damage management activities to protect other resources and private harvest.

Species	WS' Average Annual Lethal Removal (2008 to 2013)[1]			Average Annual Private Harvest (2008 to 2013)	Average Annual Commercial Transactions (2008 to 2013)[3]
	Lethal removal during activities to manage damage to livestock	Lethal removal during activities to manage damage to other resources[2]	Total lethal removal by WS		
Black bear	<1	0	<1	2,214[4] / 153[5]	n/a
Black vulture	<1*	214	214*	n/a	n/a
Bobcat	1	<1	2	1,738[6]	666
Cottontail rabbit	<1	107	107*	152,104[7]	n/a
Common raven	<1	9	9	n/a	n/a
Feral cat	<1	4	4*	n/a	n/a
Fox squirrel	<1	0	<1	45,033[7]	n/a
Grey fox	30	14	42	7,248[7] / 559[8]	2,730
Groundhog	2	130	132	117,930[7]	n/a
Opossum	16	64	80*	n/a / 1,321[8]	1,348
Raccoon	42	489	531*	42,491[7] / 3,293[8]	12,343
Skunk	2	39	40*	n/a / 491[8]	221
Turkey vulture	<1*	98	98*	n/a	n/a
Turtle[9]	<1	10	10	n/a	726[10]
White-tailed deer	6	150	156	237,731[11]/ 12,351[12]	n/a
Wild Turkey	1	9	10	20,017[13]	n/a

*Includes target animals killed unintentionally

[1]Data reported by federal fiscal year. Figures are rounded to nearest whole number. <1 is defined as any number less than one.

[2]This lethal removal is analyzed in separate analyses pursuant to the NEPA

[3]Commercial transactions include pelts purchased or brokered by fur buyers as well as snapping turtles harvested for commercial sale. Fur buyer data reported by state fiscal year, Fies 2010a, Fies 2011b, Fies 2012b, Fies 2013b, Fies 2014b.

[4]Bear harvested during hunting seasons, data reported by calendar year, J. Sajecki, VDGIF, personal communication 2015.

[5]Bear lethally removed under kill permits, data reported by calendar year, J. Sajecki, VDDIF, personal communication 2015.

[6]Data reported by state fiscal year, electronic mandatory check system, M. L. Fies, VDGIF, personal communication 2015.

[7]Hunter Harvest data reported by state fiscal year ONLY includes 2008, 2009, 2011 and 2013 data -survey not conducted in other years, Jagnow et al. 2009; VDGIF 2010, 2012; Kidd et al. 2014*a*.

[8]Trapper harvest data reported by state fiscal year ONLY includes 2013-2014 data- survey not conducted in other years, Kidd et al. 2014*b*.

[9]All turtle species combined. Majority of turtles were snapping turtles.

[10]Commercial snapping turtle harvest data, reported by calendar year, J.D. Kleopfer, VDGIF, personal communication 2015

[11]Data reported by calendar year, deer harvested and checked by hunters 2008 to 2013, W. Matt Knox, VDGIF, personal communication 2015

[12] Data reported by calendar year, deer lethally removed under VDGIF kill permits 2008 to 2013, W. Matt Knox, VDGIF, personal communication 2015

[13]Data reported by calendar year, wild turkey harvested2008 to 2013, G. Norman, VDGIF, personal communication 2014.

The capture and lethal removal that could occur as part of damage management activities to protect resources other than livestock are addressed in separate analysis pursuant to the NEPA. However, species captured and lethally removed both intentionally and unintentionally as part of those damage management activities are also addressed in this EA to ensure a cumulative evaluation of potential effects under the proposed action / no action alternative. The number of animals lethally removed unintentionally in the past by WS during activities to manage livestock predation is representative of animals that could be

lethally removed by WS under the proposed action / no action alternative. Average annual unintentional lethal removal by WS during activities to manage livestock predation did not exceed ten individuals of any species except for grey fox, opossum, and raccoon.

Average annual cumulative unintentional and intentional lethal removal of grey foxes by WS from FY 2008 to FY 2013 (43 grey fox) represents 0.6%, of the total estimated average number of grey foxes harvested annually by hunters (7,248 grey fox) or 1.5% of the total number of grey foxes pelts purchased or brokered (2,729 grey fox). Pelts purchased or brokered may have been harvested by hunters or trappers; however, the majority are harvested by trappers (M. L. Fies, VDGIF, personal communication 2015). If all the animals purchased or brokered were harvested by trappers, WS lethal removal of grey fox would represent 0.4% of the total annual average number of grey foxes harvested (9,977 grey fox). When compared to the harvest and lethal removal by private entities, the magnitude of lethal removal would be considered low.

Average annual cumulative unintentional and intentional lethal removal of opossum by WS from FY 08 to FY13 (16 opossum) represents 1.1% of the average annual total number of opossum pelts purchased or brokered by private entities (1,347 opossum). For the first time in many years the VDGIF conducted an annual survey of licensed trappers to quantify the number of animals harvested during the 2013–2014 trapping season. An estimated 7,927 opossum were harvested by trappers during that period. WS' average annual lethal removal of opossum would represent 0.2% of this figure. When compared to the harvest by private entities, the magnitude of lethal removal would be considered low.

Average annual cumulative unintentional and intentional lethal removal of raccoons by WS from FY08 to FY13 (42 raccoons) represents 0.09%, of the total estimated average number of raccoons harvested annually by hunters (42,490 raccoons) or 0.3% of the total number of raccoon pelts purchased or brokered (12,343 raccoons). Pelts purchased or brokered may have been harvested by hunters or trappers, however, the majority are harvested by trappers (M. L. Fies, VDGIF, personal communication, 2015). If all the animals purchased or brokered were harvested by trappers, WS' lethal removal of raccoons would represent 0.06% of the total annual average number of raccoons harvested (62,249 raccoons). When compared to the harvest by private entities, the magnitude of lethal removal would be considered low.

WS continually monitors, evaluates and makes modifications as necessary to methods or strategy when providing direct operational assistance, to not only reduce damage but also to minimize potentially harmful effects to non-targets. Additionally, WS would annually report lethal removal to the USFWS or VDGIF, which ensures cumulative impacts are considered as part of population management objectives. As previously mentioned, non-lethal methods are generally regarded as having minimal impacts on populations because individuals are unharmed. Therefore, non-lethal methods, including the live-capture and release of non-targets would not have any adverse impacts on non-target populations under this alternative. Lethal unintentional lethal removal could result in declines in the number of individuals in a population; however, the lethal removal of non-target animals by WS under the prosed action would not reach a magnitude where adverse effects would occur to the population of any species.

Threatened and Endangered Species

Special efforts are made to avoid jeopardizing threatened and endangered species. Threatened and endangered species listed by the USFWS or the National Marine Fisheries Service (NMFS) under the ESA for the Commonwealth can be found in Appendix C. These lists were obtained and reviewed during the development of this EA.

Federally Listed Species - WS has made a "no effect" determination for all threatened and endangered species. WS' methods and future locations of the livestock protection program do not intersect with any listed species in a manner that would affect those listed species.

State Listed Species - The current list of species designated as endangered, threatened, or special concern by the state, as determined by the VDGIF, was obtained and reviewed during the development of the EA (see Appendix D). Based on the review of species listed, WS has determined that the proposed activities would have no effect on the species currently listed by the state.

Summary of non-target animal impact analysis

Based on WS' determination, the employment of methods by WS would not likely adversely directly or cumulatively affect any non-targets, including threatened and endangered species. No potential indirect effects were identified. WS continually monitors, evaluates and makes modifications as necessary to methods or strategy when providing direct operational assistance, to not only reduce damage but also to minimize potentially harmful effects to non-targets. Additionally, WS consults with the USFWS and the VDGIF to determine the potential risks to eagles, federally and state listed threatened and endangered species in accordance with the Bald and Golden Eagle Protection Act, ESA and Commonwealth laws and annually reports to these entities to ensure that any non-target lethal removal by WS is considered as part of management objectives. Potential direct and cumulative impacts to non-targets, including threatened and endangered species from the recommendation of methods by WS, under this alternative would be expected to be insignificant.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs or red foxes with technical assistance only. Direct operational assistance provided by WS as described above would not be available.

Despite no direct involvement by WS in resolving damage and threats to livestock, those persons experiencing damage caused by coyotes, dogs or red foxes could continue to alleviate damage by employing both non-lethal and lethal methods. Appendix C contains a thorough discussion of the methods available for use in managing damage and threats to livestock associated with coyotes, dogs or red foxes. With the exception of Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide), all methods listed in the Appendix could be available under this alternative. Non-lethal methods have the potential to inadvertently disperse non-target animals while lethal methods have the potential to inadvertently capture or kill non-target animals.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action. Therefore, non-target populations would not be directly impacted by WS from a program implementing technical assistance only.

If direct operational assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats could lead to the inappropriate use of legal methods or the use of illegal methods which could lead to real but unknown effects on other animal populations. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003).

Potential impacts to non-target animals, including threatened and endangered species from the recommendation of methods by WS under this alternative would be variable. If methods were employed as recommended by WS, potential direct or cumulative risks to non-targets would likely be low and similar to the proposed action / no action alternative. WS' involvement would not be additive to lethal removal that could occur since the individual requesting WS' assistance could conduct damage management activities without WS' involvement. However, if methods were not employed as recommended or methods that are not recommended were employed, potential direct, indirect or cumulative impacts to non-targets are likely to be higher.

Alternative 3 – WS Would Not Address Damage to Livestock

WS would not be involved with any aspect of managing damage to livestock associated with coyotes, dogs or red foxes. Therefore, WS would have no direct impact to non-targets or threatened and endangered species under this alternative. All requests for assistance received by WS to resolve damage to livestock caused by coyotes, dogs or red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. Lethal removal could continue as stated under Alternative 2.

This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats to livestock could take action using those methods legally available to resolve or prevent damage to livestock as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

Potential impacts to non-target species, including threatened and endangered species would be variable under this alternative. If direct operational assistance and technical assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. Illegal, unsafe, and environmentally unfriendly actions could lead to unnecessary killing of non-target animals. In the past, people have resorted to the illegal use of chemicals and methods to alleviate wildlife damage issues (White et al. 1989, USFWS 2001, FDA 2003). However, if appropriate direct operational assistance and technical assistance was provided by persons knowledgeable and experienced in managing damage associated with coyotes, dogs or red foxes, the risks would be similar to Alternative 2.

Issue 4 - Effects of Damage Management Activities on Human Health and Safety

An additional issue often raised is the potential risks to human health and safety associated with the methods employed to manage damage to livestock associated with coyotes, dogs and red foxes. Both chemical and non-chemical methods have the potential to have adverse direct, indirect or cumulative effects on human health and safety. Risks can occur both to persons employing methods and persons coming into contact with methods. Risks can be inherent to the method itself or related to the misuse of the method. Potential effects of damage management activities on human health and safety under each of the three alternatives are analyzed below.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

Under the proposed action / no action alternative, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance.

Standard Operating Procedures (SOPs) for coyote, dog and red fox damage management in Virginia discussed in Chapter 3 ensure risks to human health and safety would be reduced or prevented. Pertinent SOPs include not only the WS Decision Model (WS Directive 2.201), an evaluation process for the appropriateness of methods (WS Directive 2.101) and the use of integrated management (WS Directive 2.105), but also several other precautions including the following. WS identifies hazards in advance of work assignments and provides employees with personal protective equipment (PPE). WS employees must adhere to safety requirements and use appropriate PPE. WS employees are required to work cooperatively to minimize hazards and immediately report unsafe working conditions (WS Directive 2.601). Damage management activities would be conducted away from areas of high human activity (e.g., in areas closed to the public) or during periods when human activity is low (e.g., early mornings, at night) to the extent possible. WS would only conduct livestock damage management activities on a given property in response to a request for assistance after the property owner or manger has signed a document agreeing to allow the use of specific methods on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons contact and inform persons utilizing or adjoining the property of control activities. Although hazards to human health and safety from both non-lethal and lethal methods exist, those methods would generally be regarded as safe when used by individuals trained and experienced in their use and with regard and consideration of possible risks to human health and safety.

Non-chemical methods available for use under any of the alternatives are live-capture traps (e.g., foot hold traps) and snares (cable devices) (see Appendix C). The risk live-capture traps and snares (cable devices) pose to human health and safety are small to non-existent. Live capture traps can only be triggered through direct activation of the device. Therefore, if left undisturbed, these traps would pose no risk. WS would use traps and snares in compliance with applicable federal, state and local laws and regulations (WS Directive 2.210) as well as WS Directives. WS would not implement these methods in locations or in such a manner in which they would pose hazards to WS staff or the public. When recommending these methods, WS would caution those persons against their misuse.

WS personnel are trained and experienced in the use of firearms. WS employees who use shooting as a method must comply with WS Directive 2.615 and all standards described in the WS Firearms Safety Training Manual. Directive 2.615 requires that personnel undergo regular training, adhere to a set of safety standards, submit to drug testing, and are subject to the Lautenberg Amendment. WS' recommendation that hunting or shooting be used would not increase risks to human health and safety above those already inherent. When used appropriately and with consideration of human safety, risks associated with firearms are minimal. When recommending that hunting or shooting be used, WS would caution against the improper use of firearms. Because the use of firearms would be available under any of the alternatives and their use could occur whether WS was consulted or not, the risks to human health and safety would be similar among all the alternatives.

All chemical methods listed in Appendix B could be available under this alternative, although not all methods would be available for direct implementation by all persons. Livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide) are only available for use by WS. The use of chemical methods is strictly regulated by the EPA, FDA and VDACS. With the exception of large gas cartridges, repellants and attractants, chemicals can only be applied by persons who have been

specifically trained and certified by the VDACS for their use. Chemical methods used or recommended by WS would be registered as required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)(see Appendix B). When recommending these methods, WS would caution those persons against their misuse. WS personnel that use restricted use chemicals would be certified as pesticide applicators by the Commonwealth of Virginia and would be required to wear appropriate PPE they are provided with (WS Directive 2.601). Following label requirements eliminates risks to human health and safety.

M-44s would be used by WS in accordance with the label and EPA's use restrictions to minimize risks to human health and safety (WS Directive 2.415). WS use of M-44s would be restricted to fenced areas where livestock graze in accordance with WS Directive 2.415(c). Because M-44s administer sodium cyanide in a single dose, the risk of exposure is primarily dependent upon a person approaching and physically triggering a device by pulling on the top of the device which is staked into the ground and covered in a fetid attractant or lure. Sodium cyanide is supplied by the manufacture to the applicator in sealed single dose capsules which are inserted directly into the M-44 device. Requirements for storage, transport and application of these capsules eliminates the likelihood that humans would be exposed to sodium cyanide in the environment. Thus, a potential impact to humans from environmental exposure is minimal to non-existent. Of additional concern is the potential exposure of people to animals that have ingested sodium cyanide. However, the chemical reaction and mode of action (chemical asphyxiation) limits the amount of compound present in the environment or in tissues that could be available to persons handling or consuming these animals (Howard and Hanzal 1955). Additionally, if ingested at sub-toxic levels, sodium cyanide is rapidly detoxified and excreted by the kidneys (EPA 2006*a*, HSDB 2015).

LPCs are only available for use by WS and would be used in accordance with the label and technical bulletin (WS Directive 2.420). The LPC, designed to fit around the neck of a sheep or goat, has rubber pouches which contain a diluted sodium fluoroacetate solution. The risk of exposure is primarily dependent upon a person encountering a flock of sheep or goats with LPCs in a fenced pasture and ingesting sodium fluoroacetate from a punctured collar. However, a yellow dye added to sodium fluoroacetate solutions used in LPCs to serve as a contamination indicator and label requirements for the application of LPCs reduces these risks (tech bulletin). Sodium fluoroacetate is not readily absorbed through the skin (Atzert 1971). LPCs are supplied by the manufacturer with the proper dosage of sodium fluoroacetate contained within the rubber pouches. Requirements for storage transport and application of LPCs and sodium fluoroacetate contaminated material eliminates the likelihood that humans would be exposed to this substance in the environment (EPA 1995). Of additional concern is the potential exposure of people to animals that have ingested sodium fluoroacetate. Secondary toxicity to humans could theoretically occur from a human consuming the carcass of an animal receiving a lethal dose from an LPC or from a human making oral contact with an animal having recently vomited after consuming sodium fluoroacetate. However, secondary poisoning is unlikely because the levels of sodium fluoroacetate that persist in the tissues of animals receiving a lethal dose is relatively low (Connolly 1980, Littauer 1983), the use of contaminated animals for food is prohibited (WS Directive 2.415) and the amount of vomit that would be ingested would likely be extremely small making secondary poisoning minimal to non-existent.

No adverse effects to human safety occurred from WS' use of methods to alleviate damage to livestock associated with coyotes, dogs or red foxes in Virginia from FY 2008 to FY 2013. The direct, indirect or cumulative risks to human safety from the use of chemical and non-chemical methods, when used appropriately and by trained personnel, is considered insignificant. The amount of chemicals used or stored by WS and cooperating agencies would be minimal to ensure human safety. Based on potential use patterns, the chemical and physical characteristics of the above mentioned chemical methods, and factors related to the environmental fate, no direct, indirect or cumulative impacts are expected from the chemical components used or recommended by the WS program.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs or red foxes with technical assistance only. Direct operational assistance provided by WS as described above would not be available. This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals.

Despite no direct involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-chemical and chemical methods. With the exception of livestock protection collars (*sodium fluoroacetate*) and M-44s (sodium cyanide), all methods listed in Appendix B could be available under this alternative. Private efforts to reduce or prevent damage would be expected to increase, and would likely result in less experienced persons implementing damage management methods which may have a greater risk to human health and safety than under Alternative 1. Ignorance and/or frustration caused by the inability to reduce losses could lead to illegal use of toxicants by others which could lead to unknown impacts to humans.

Potential impacts to human health and safety from the recommendation of methods by WS under this alternative would be variable. If methods were employed as recommended by WS and according to label requirements, in the case of chemical methods (e.g., large gas cartridges), potential risks to human health would likely be similar to the proposed action / no action alternative. However, if methods were not employed as recommended or methods that are not recommended are employed, risks could increase.

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not be involved with any aspect of managing damage to livestock associated with coyotes, dogs or red foxes. Therefore, WS would have no direct impact to human health and safety under this alternative. All requests for assistance received by WS to resolve damage to livestock associated with coyotes, dogs or red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-chemical and chemical methods. This alternative would place the immediate burden of operational damage management work on the resource owner, other governmental agencies, private businesses and/or private individuals. Those persons experiencing damage or threats could take action using those methods legally available to resolve or prevent damage as permitted by federal, Commonwealth, and local laws and regulations or those persons could take no action.

Potential impacts to human health and safety would be variable under this alternative. If direct operational assistance and technical assistance is not provided by WS or other entities, it is possible that frustration caused by the inability to reduce damage and threats along with ignorance on how best to reduce damage and threats could lead to the inappropriate use of legal methods and the use of illegal methods. Illegal, unsafe, and environmentally unfriendly actions could lead to higher risk to health and safety. However, if appropriate direct operational assistance and technical assistance was provided by persons knowledgeable and experienced in managing damage to livestock caused by coyotes, dogs or red foxes, the risks would be similar to Alternative 2.

Issue 5 – Humaneness and Animal Welfare Concerns

As described in Chapter 2, humaneness and animal welfare concerns associated with methods available to reduce damage to livestock associated with coyotes, dogs or red foxes has been identified as an issue. The humaneness and animal welfare concerns of the methods as they relate to the alternatives are discussed below.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

Under the proposed action / no action alternative, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance.

Humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal, and 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.

WS may use EPA registered and approved chemicals to manage damage caused by coyotes, red foxes and dogs. Some individuals consider the use of such chemicals to be inhumane. WS personnel are experienced, professional, and humane in their use of management methods. Under this alternative, coyotes, red foxes and feral dogs could be killed by experienced WS personnel using the best and most appropriate method(s) available.

The AVMA states "... euthanasia is the act of inducing humane death in an animal" and that "... if an animal's life is to be taken, it is done with the highest degree of respect, and with an emphasis on making the death as painless and distress free as possible" (AVMA 2013). Additionally, euthanasia methods should minimize any stress and anxiety experienced by the animal prior to unconsciousness." Although use of euthanasia methods to end an animal's life is desirable, as noted by the AVMA, for wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but use terms such as killing, collecting, or harvesting, recognizing that a distress- free death may not be possible (AVMA 2007).

AVMA (2013) notes, "While recommendations are made, it is important for those utilizing these recommendations to understand that, in some instances, agents and methods of euthanasia identified as appropriate for a particular species may not be available or may become less than an ideal choice due to differences in circumstances." Conversely, when settings are atypical, methods normally not considered appropriate may become the method of choice. Under such conditions, the humaneness (or perceived lack thereof) of the method used to bring about the death of an animal may be distinguished from the intent or outcome associated with an act of killing. Following this reasoning, it may still be an act of euthanasia to kill an animal in a manner that is not perfectly humane or that would not be considered appropriate in other contexts. For example, due to lack of control over free-ranging wildlife and the stress associated with close human contact, use of a firearm may be the most appropriate means of euthanasia. Also, shooting a suffering animal that is in extremis, instead of catching and transporting it to a clinic to euthanize it using a method normally considered to be appropriate (e.g., barbiturates), is consistent with one interpretation of a good death. The former method promotes the animal's overall interests by ending its misery quickly, even though the latter technique may be considered to be more acceptable under normal conditions (Yeates 2010). Neither of these examples, however, absolves the individual from her or his responsibility to ensure that recommended methods and agents of euthanasia are preferentially used."

AVMA (2013) recognizes that there is "an inherent lack of control over free-ranging wildlife," accepting that firearms may be the most appropriate approach to their euthanasia, and acknowledging that the quickest and most humane means of terminating the life of free-ranging wildlife in a given situation may not always meet all criteria established for euthanasia (i.e., distinguishes between euthanasia and methods that are more accurately characterized as humane killing). Because of the variety of situations that may be encountered, it is difficult to strictly classify methods for termination of free-ranging wildlife as acceptable, acceptable with conditions, or unacceptable. Furthermore, classification of a given method as a means of euthanasia or humane killing may vary by circumstances. These acknowledgments are not intended to condone a lower standard for the humane termination of wildlife. The best methods possible under the circumstances must be applied, and new technology and methods demonstrated to be superior to previously used methods must be embraced.

With the exception of M-44s (sodium cyanide) and LPCs (sodium fluoroacetate), all methods listed in the Appendix B would be available under all alternatives. An assessment of humaneness of specific toxicants can include the time that elapses until death. Sodium cyanide is a fast acting chemical administered in a single dose in the M-44 device (EPA 2006*b*). The majority of coyotes triggering M-44 devices and receiving a dose of sodium cyanide died within 1–5 minutes (Burns et al. 1990). Sodium fluoroacetate is administered via the LPC (EPA 1995). Six coyotes puncturing LPCs containing 30 ml of a 1% active ingredient solution fitted around the neck of sheep died in an average of 279 minutes (Burns et al. 1984b) and ten coyotes died in an average of 295 minutes (Burns and Mason 1996). While sodium fluoroacetate is slower acting than sodium cyanide it is much faster than commonly used anticoagulant rodenticides (1-3 weeks, multiple dosages). For example, the average time of death for bushtail opossums exposed to brodifacoum was 21 days (Littin et al. 2002).

The efficacy and therefore, the humaneness of methods would be based on the skill and knowledge of the person employing methods. WS personnel are experienced professionals skilled in their use of methods. When selecting methods, WS evaluates all potential tools for their humaneness, effectiveness, ability to target specific species and individuals, as well as other factors. Consequently, management methods would be implemented by WS in the most humane manner possible. With the exception of M-44s and LPCs all methods listed in the Appendix B would be available for use under any of the alternatives. Therefore, the issue of humaneness associated with methods and any direct impacts would be similar across any of the alternatives since those methods could be employed in the absence of WS' involvement. Those persons who view a particular method as humane or inhumane would likely continue to view those methods as humane or inhumane under any of the alternatives. SOPs that would be incorporated into WS' activities to ensure methods were used by WS as humanely as possible are listed in Chapter 3.

WS has improved the selectivity and humaneness of management techniques through research and development. Research is continuing to bring new findings and products into practical use. Until new findings and products are found practical, a certain amount of animal suffering could occur when some methods are used in situations where non-lethal damage management methods are not practical or effective. No indirect or cumulative adverse impacts were identified for this issue.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs and red foxes with technical assistance only. Direct operational assistance provided by WS as described above would not be available.

Despite no direct involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs and red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. The issue of humaneness of methods under this

alternative is likely to be perceived as similar to humaneness issues discussed under the proposed action / no action alternative. This perceived similarity is derived from WS' recommendation of methods that some consider inhumane. WS would not directly be involved with damage management activities under this alternative. However, the recommendation of the use of methods would likely result in the requester employing those methods. Therefore, by recommending methods and thus a requester employing those methods, the issue of humaneness would be similar to the proposed action / no action alternative.

WS could instruct and demonstrate the proper use and placement of methodologies to increase effectiveness in capturing target species and to ensure methods are used in such a way as to minimize pain and suffering. However, the efficacy of methods employed by an individual would be based on the skill and knowledge of the requester in resolving the damage despite WS' demonstration. Therefore, a lack of understanding of the behavior of coyotes, dogs or red foxes or the improper identification of the animal causing damage along with inadequate knowledge and skill in using methodologies to alleviate the damage or threats to livestock could lead to incidents with a greater probability of being perceived as inhumane. In those situations, the pain and suffering are likely to be regarded as greater than those discussed in the proposed action / no action alternative.

Those people requesting assistance would be directly responsible for the use and placement of methods and if monitoring or checking of those methods does not occur in a timely manner, captured animals could experience suffering or distress. The amount of time an animal is restrained under the proposed action / no action alternative would be shorter compared to a technical assistance alternative if those requesters implementing methods are not as diligent or timely in checking methods. If those persons seeking assistance from WS apply methods recommended by WS as intended, then those methods would be applied as humanely as possible to minimize pain and distress. If those persons provided technical assistance by WS apply methods not recommended by WS or do not employ methods as intended or without regard for humaneness, then the issue of method humaneness would be of greater concern since pain and distress of animals would likely be higher.

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not be involved with any aspect of managing damage to livestock associated with coyotes, dogs and red foxes. All requests for assistance received by WS to resolve damage to livestock associated with coyotes, dogs and red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs and red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. Those methods would likely be considered inhumane by those persons who would consider methods proposed under any alternative as inhumane. The issue of humaneness would likely be directly linked to the methods legally available to the public since methods are often labeled as inhumane by segments of society no matter the entity employing those methods. A method considered inhumane would still be perceived as inhumane regardless of the person or entity applying the method. However, even methods generally regarded as being humane could be employed in inhumane ways. Methods could be employed inhumanely by those people inexperienced in the use of those methods or if those people were not as diligent in attending to those methods.

The efficacy and therefore, the humaneness of methods would be based on the skill and knowledge of the person employing those methods. A lack of understanding of the target species or methods used could lead to an increase in situations perceived as being inhumane despite the method used. Despite the lack of involvement by WS under this alternative, those methods perceived as inhumane by certain individuals and groups would still be available to the public to use to alleviate damage and threats to livestock

associated with coyotes, dogs and red foxes. Therefore, those methods considered inhumane would continue to be available for use under this alternative. If those people experiencing damage to livestock apply those methods considered humane methods as intended and in consideration of the humane use of those methods, then the issue of method humaneness would be similar across the alternatives. If those persons experiencing damage were not provided with information and demonstration on the proper use of those methods and employed humane methods in ways that were inhumane, the issue of method humaneness could be greater under this alternative. However, the level at which people would apply humane methods inhumanely under this alternative based on a lack of assistance is difficult to determine and could just as likely be similar across the alternatives.

Issue 6 – Effects of Damage Management Activities on the Aesthetic Values of Coyote, Dog and Red Fox

People often enjoy watching or hearing coyotes and red foxes and take pleasure from knowing they exist as part of the natural environment. The aesthetic value of dogs may for some people be linked to their status (i.e. owned and under the owner's direct control, owned but free-ranging or feral). Some owners may never confine or restrain their pet and enjoy knowing they have the freedom of being free-ranging. These people may view their pet differently than an un-owned free-ranging or feral animal. Those methods available to alleviate damage to livestock are intended to disperse and/or remove coyotes, dogs or red foxes. These activities reduce the presence of target species in the area where damage is occurring. Therefore, these activities have the potential to affect the aesthetic values of coyote, dog and red fox depending upon the values, philosophies, attitudes and opinions of individuals. The effects on the aesthetic value of coyote, dog and red fox as it relates to the alternatives are discussed below.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

Under the proposed action / no action alternative, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance.

The implementation or recommendation of methods by WS under this alternative would likely result in the dispersal, exclusion, or removal of individual coyotes, dogs or red foxes to alleviate damage and threats to livestock. In some instances where animals were dispersed or removed, the ability of interested persons to observe and enjoy these animals could temporarily decline. Even the use of exclusionary devices could lead to the dispersal of animals if the resource being damaged was acting as an attractant, because once the attractant was removed or made unavailable, the animals causing the damage would likely disperse to other areas. Those animals removed, dispersed or lethally removed by WS under this alternative, would likely be those same animals that could and likely would be removed, dispersed or lethally removed by those individuals experiencing damage to livestock in the absence of assistance from WS. Since those animals removed, dispersed or lethally removed by WS under this alternative could be removed by other entities, WS' involvement would not likely be additive to the number of animals that could be lethally removed in the absence of WS' involvement. The lethal removal of coyotes can occur at any time, lethal removal of dogs or hybrid canines can occur when they are "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock"(§ 3.2-6552, § 3.2-6583) and lethal removal of foxes can occur when they are causing damage or a nuisance or at any time by a landowner or their designee, or during hunting and trapping seasons.

WS' lethal removal of coyotes, dogs and red foxes over the last six years has been of low magnitude when compared to the private harvest of coyotes and red foxes and the number of dogs that were euthanized and died while in the custody of Virginia's rescue agencies, city and county facilities (see

Issue 1, Alternative 1 and Issue 2, Alternative 1 for additional information on impacts to target animals). Given the limited lethal removal proposed by WS under this alternative when compared to the known sources of mortality and population information, livestock damage management activities conducted by WS pursuant to the proposed action / no action alternative would not adversely affect the aesthetic value of coyote, dog or red fox.

When damage to livestock associated with coyotes, dogs or red foxes has occurred, any removal of animals by the property or resource owner would likely occur whether WS was involved with taking the animals or not. Therefore, the activities of WS are not expected to have any direct, indirect or cumulative adverse effects on this element of the human environment if occurring at the request of a property owner and/or manager.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes, dogs or red foxes with technical assistance only. Direct operational assistance provided by WS as described above would not be available.

The provision of technical assistance by WS under this alternative is unlikely to increase the number of animals addressed because those individuals experiencing damage could and likely would employ both lethal and non-lethal methods in the absence of WS' assistance. Since animals could continue to be lethally removed, removed or dispersed under this alternative, despite WS' lack of direct involvement, the aesthetic values associated with coyote, dog or red fox would likely be similar to the other alternatives. The lack of WS' direct involvement would not lead to a reduction in the number of animals removed, dispersed or lethally removed since WS has no authority to regulate the removal, harassment or lethal removal of coyote, dog or red fox. That authority rests with the VDGIF (in the case of coyotes and red foxes), VDACS, or local law enforcement or animal control authorities (in the case of dogs). Because those individuals experiencing damage could and likely would continue to employ both lethal and non-lethal methods, despite WS' lack of direct involvement under this alternative, the impacts to the aesthetic value of coyote, dog or red fox and any direct, indirect or cumulative impacts would be similar to the other alternatives. Impacts would only be lower than the proposed action / no action alternative if those individuals experiencing damage were not as diligent in employing methods as WS would be if conducting direct operational assistance. If those people experiencing damage abandoned the use of those methods then coyotes, dogs and red foxes would likely remain in the area and available for watching or hearing for those people interested in doing so.

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not be involved with any aspect of livestock damage management. Therefore, WS would have no direct impact on the aesthetic values of coyote, dog or red fox under this alternative. All requests for assistance received by WS to resolve damage to livestock associated with coyotes, dogs and red foxes would be referred to the VDGIF, the VDACS, local law enforcement or animal control authorities and/or private entities. Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes, dogs or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods.

Since animals could continue to be removed, harassed or lethally removed under this alternative, despite WS' lack of involvement, the ability to watch or hear these animals would likely be similar to the other alternatives. The lack of WS' involvement would not lead to a reduction in the number of animals removed, harassed or lethally removed since WS has no regulatory authority. That authority rests with the VDGIF (in the case of coyote and red fox), VDACS, or local law enforcement or animal control

authorities (in the case of dogs). Under this alternative, those individuals experiencing damage to livestock could and likely would continue to employ both lethal and non-lethal methods, despite WS' lack of involvement. Therefore, the impacts to the aesthetic value of coyote, dog and red fox and any direct, indirect or cumulative impacts would be similar to the other alternatives. Impacts would only be lower than the proposed action / no action alternative if those individuals experiencing damage were not as diligent in employing methods as WS would be if conducting direct operational assistance. If those people experiencing damage abandoned the use of those methods then coyotes, dogs or red foxes would likely remain in the area for watching or hearing for those people interested in doing so.

Issue 7 – Effects of Damage Management Activities on the Regulated Harvest of Coyotes and Red Foxes

Another issue commonly identified as a concern is that damage management activities conducted by WS could affect the ability of hunters or trappers to harvest species targeted by management activities. Potential impacts could arise from both lethal and non-lethal damage management methods. Non-lethal methods disperse or otherwise make an area where damage is occurring unattractive to the species (target species) causing the damage, thereby reducing the presence of those species in the area. Lethal methods remove individuals of the target species causing the damage, thereby reducing the local population and the presence of those species in the area. Therefore, lethal methods could reduce the local population or the presence of coyotes or red foxes in the area where damage management activities are occurring. In the Commonwealth, coyotes and red foxes may be harvested by hunters and trappers.

Alternative 1 – WS Would Continue to Address Damage to Livestock through an Adaptive Integrated Approach (Proposed Action / No Action Alternative)

Under the proposed action / no action alternative, WS could provide both technical assistance and direct operational assistance to those persons requesting assistance.

The proposed number of lethally removed coyotes and red foxes would be of low magnitude when compared to the private harvest of coyotes and red foxes (see Issue 1, Alternative 1 for additional species specific information). Given the increasing number of observations of coyotes and the stable number of observations of red foxes during the bowhunter survey, WS' proposed lethal removal of coyote and red fox and lethal removal from all known sources cumulatively is below the level of removal that would cause a decrease in the population.

The VDGIF is responsible for classifying mammals as game animals (e.g. red fox, Title 29.1, Chapter 5, section 516) or nuisance species (e.g. coyote, Title 29.1, Chapter 5, section 100) and establishing and enforcing hunting and trapping seasons and licensing fur dealers. With oversight by the VDGIF, the lethal removal of coyotes or red foxes by WS or the recommendation of lethal methods by WS would not limit the ability to harvest coyotes or red foxes. All lethal removal by WS would be reported to VDGIF annually to ensure that removal by WS is incorporated into cumulative population management objectives established for coyotes and red foxes. Based on the limited lethal removal proposed by WS and the oversight by VDGIF, WS' lethal removal of coyotes and red foxes under this alternative would have no direct or cumulative effect on the ability of those people interested in doing so to harvest coyotes or red foxes. No potential indirect effects were identified.

Alternative 2 – WS Would Address Damage to Livestock Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats to livestock associated with coyotes or red foxes with technical assistance only. Direct operational assistance provided by WS as described above would not be available.

The provision of technical assistance by WS under this alternative is unlikely to increase the number of coyotes or red foxes addressed because those individuals experiencing damage likely would employ both lethal and non-lethal methods in the absence of WS' assistance. Since coyotes and red foxes could continue to be lethally removed or dispersed under this alternative, despite WS' lack of direct involvement, the ability to harvest these animals would be similar among the alternatives. WS' recommendation of methods would not limit the ability of those people interested in harvesting coyotes and red foxes from doing so. The number of coyotes and red foxes lethally removed annually would be regulated and adjusted by the VDGIF. Direct, indirect and cumulative effects would be similar to alternative 1.

Alternative 3 – WS Would Not Address Damage to Livestock

Under this alternative, WS would not be involved with any aspect of livestock damage management associated with coyote or red fox. Therefore, WS would have no direct impact on the ability to harvest coyotes or red foxes under this alternative. Despite no involvement by WS in resolving damage and threats to livestock associated with coyotes or red foxes, those persons experiencing damage could continue to alleviate damage by employing both non-lethal and lethal methods. The number of coyotes and red foxes lethally removed annually would be regulated and adjusted by the VDGIF. Direct, indirect and cumulative effects would be similar to alternative 1.

4.2 SUMMARY OF ENVIRONMENTAL CONSEQUENCES UNDER THE PROPOSED ACTION / NO ACTION ALTERNATIVE

No significant cumulative environmental impacts are expected from any of the three Alternatives. Under the proposed action /no action alternative, the lethal removal of coyotes, dogs and red foxes by WS would not have a significant impact on overall coyote, dog, or red fox populations in Virginia, but some short-term local reductions may occur. Additionally, WS would not have a significant direct or cumulative impact on the regulated harvest of coyotes and red foxes. WS would not have a significant direct, indirect or cumulative impact on non-target animal populations or threatened and endangered species. Under the proposed action / no action alternative, direct impacts to human health and safety would be low and indirect and cumulative impacts would be eliminated when methods are used appropriately in adherence with SOPs and label requirements by trained personnel. Similarly, adherence to SOPs and selection and implementation of methods by trained personnel insures methods would be implemented in the most humane manner possible under the proposed action / no action alternative. Any direct, indirect or cumulative impacts on humaneness would be in part up to a person's perception of humaneness and similar across the alternatives. Under the proposed action / no action alternative, the aesthetic values of coyote, dog and red fox are not expected to be impacted directly, indirectly or cumulatively. WS' actions taken to minimize or eliminate damage would be constrained in scope, duration and intensity, for the purpose of minimizing or avoiding impacts. WS' SOPs are designed to reduce the potential negative effects of WS' actions by identifying and responding to both anticipated and unanticipated changes in wildlife populations and the environment. WS continually monitors, evaluates and makes modifications as necessary to methods or strategy when providing assistance, to not only reduce damage, but also to identify and minimize potentially harmful effects. This process allows WS to take into consideration other influences in the environment in order to avoid adverse impacts. Although some persons will likely be opposed to WS' participation in damage management activities, the analysis in this EA indicates that WS' integrated damage management program to protect livestock, as described in the proposed action/ no action alternative, would not result in significant adverse cumulative impacts on the quality of the human environment.

CHAPTER 5 - LIST OF PREPARERS AND PERSONS CONSULTED

5.0 List of Preparers and Reviewers

Scott Barras	USDA, APHIS, WS – State Director
Jennifer Cromwell	USDA, APHIS, WS – Assistant State Director
Lauren Mastro	USDA, APHIS, WS – Wildlife Biologist
Chris Croson	USDA, APHIS, WS – Staff Wildlife Biologist

APPENDIX A: LITERATURE CITED

Acorn, R. C. 1997. Protecting livestock from predation with electric fences. Agdex 684-7. Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada.

Acorn, R. C., and M. J. Dorrance. 1990. Methods of investigating predation of livestock. 2012, reprint. Alberta Agriculture, Crop Production Branch, Edmonton, Alberta, Canada.

Acorn, R. C., and M. J. Dorrance. 1994. An evaluation of anti-coyote electric fences. Proceedings of the Vertebrate Pest Conference 16:45–50.

Adams, J. R., J. A. Leonard, and L. P. Waits. 2003. Widespread occurrence of a domestic dog mitochondrial DNA haplotype in southeastern U.S. coyotes. Molecular Ecology 12:541–546.

Amaku, M., R. A. Dias, and F. Ferreira. 2010. Dynamics and control of stray dog populations. Mathematical Population Studies 17:69–78.

American Veterinary Medical Association (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.

American Veterinary Medical Association (AVMA). 2001. 2000 report of the AVMA panel on euthanasia. Journal of the American Veterinary Medical Association 218: 669–696.

American Veterinary Medical Association (AVMA). 2007. American Veterinary Medical Association guidelines on euthanasia (formerly the AVMA panel on Euthanasia). American Veterinary Medical Association. Schaumburg, Illinois, USA.

American Veterinary Medical Association (AVMA). 2013. AVMA Guidelines for the Euthanasia of Animals: 2013 Edition. American Veterinary Medical Association. Schaumburg, Illinois, USA.

Andelt, W. F. 1992. Effectiveness of livestock guarding animals for reducing predation on domestic sheep. Wildlife Society Bulletin 20:55–62.

Andelt, W. F. 2004. Use of livestock guarding animals to reduce predation on livestock. Sheep & Goat Research Journal 19:72–75.

Andelt, W. F., and S. N. Hopper. 2000. Livestock guard dogs reduce predation on domestic sheep in Colorado. Journal of Range Management 53:259–267.

Anderson, D. M., C. V. Hulet, J. N. Smith, W. L. Shupe, and L. W. Murray. 1987. Bonding of young sheep to heifers. Applied Animal Behavior Science 19:31–40.

Association of Fish and Wildlife Agencies (AFWA). 2014*a*. Best management practices: trapping coyotes in the eastern United States. Association of Fish and Wildlife Agencies, Washington, D.C., USA.

Association of Fish and Wildlife Agencies (AFWA). 2014*b*. Best management practices: trapping red foxes in the United States. Association of Fish and Wildlife Agencies, Washington, D.C., USA.

Atwood, T. C. 2006. The influence of habitat patch attributes on coyote group size and interaction in a fragmented landscape. Canadian Journal of Zoology 84:80–87.

Atzert, S. P. 1971. A review of sodium monofluoracetate (compound 1080) its properties, toxicology, and use in predator and rodent control. Special Scientific Report 146. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Washington, D.C., USA.

Baker, P., J. S. Harris, C. P. J. Roertson, G. Saunders, and P. C. L. White. 2001. Differences in the capture rate of cage-trapped red foxes *vulpes vulpes* and an evaluation of rabies control measures in Britain. Journal of Applied Ethology 38:823–835.

Bartel, R. A., and M. W. Brunson. 2003. Effects of Utah's coyote bounty program on harvester behavior. Wildlife Society Bulletin 31:736–743.

Barling, K. S., M. Sherman, M. J. Peterson, J. A. Thompson, J. W. McNeill, T. M. Craig, and L. G. Adams. 2000. Spatial associations among density of cattle, abundance of wild canids and seroprevalance to *Neospora caninum* in a population of beef calves. Journal of the American Veterinary Medical Association 217:1361–1365.

Balser, D. S. 1974. An overview of predator–livestock problems with emphasis on livestock losses. Transactions of the North American Wildlife Resource Conference 39:292–300.

Bartlett, P. C., A. Bartlett, S. Walshaw, and S. Halstead. 2005. Rates of euthanasia and adoption for dogs and cats in Michigan animal shelters. Journal of Applied Animal Welfare Science 8:97–104.

Bateson, P. 1991. Assessment of pain in animals. Animal Behaviour 42:827–839.

Bekoff, M. and E. M. Gese. 2003. Coyotes. Pages 467–481 *in* G. A. Feldhamer, B. C. Thompson, and J. A Chapman, editors. Wild Mammals of North America: biology, management and economics, 2nd edition. Johns Hopkins University Press, Baltimore, Maryland, USA.

Bekoff, M., and M. C. Wells. 1986. Social ecology and behavior of coyotes. Advances in the Study of Behavior 16:251–338.

Berger, J., and R. Rudman. 1985. Predation and interactions between coyotes and feral horse foals. Journal of Mammalogy 66:401–402.

Bergman, D. L., S. W. Breck, and S. C. Bender. 2009. Dogs gone wild: feral dog damage in the United States. Proceedings of the 13th Wildlife Damage Management Conference 13:177–183.

Blair, B. J., and T. W. Townsend. 1983. Dog predation of domestic sheep in Ohio. Journal of Range Management 36:527–528.

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.

Boggess, E. K., R. D. Andrews, and R. A. Bishop. 1978. Domestic animal losses to coyotes and dogs in Iowa. Journal of Wildlife Damage Management 42:362–372.

Boggess, E. K., F. R. Henderson, and C. W. Spaeth. 1980. Managing predator problems: practices and procedures for preventing and reducing livestock losses. Cooperative Extension Service, Kansas State University, Manhattan, Kansas, USA.

Breck, S. and T. Meier. 2004. Managing wolf depredation in the untended states: past present and future. Sheep and goat research journal 19:41–46.

Breig, J. 2004. The eighteenth century goes to the dogs. Colonial Williamsburg Journal 26:22–27.

Bromley, C., and E. M. Gese. 2001. Surgical serialization as a method of reducing coyote predation on domestic sheep. Journal of Wildlife Management 65:510–519.

Bulte, E. H., and D. Rondeau. 2005. Why compensating wildlife damages may be bad for conservation. Journal of Wildlife Management 69:14–19.

Burns, R. J., and G. E. Connolly. 1995. Assessment of potential toxicity of compound 1080 from livestock protection collars to canines and scavenging birds. International Biodeterioration and Biodegradation 1&2:161–167.

Burns, R. J., G. E. Connolly, and R. E. Griffiths, Jr. 1984*a*. Repellent or aversive chemicals in sheep neck collars did not deter coyote attacks. Proceeding of the Vertebrate Pest Conference 11:146–153.

Burns, R. J., G. E. Connolly, D. L. Meeker, I. Okuno, and P. J. Savarie. 1984*b*. Efficacy and hazards of Compound 1080 in toxic collars. A submission to the U.S. Environmental Protection Agency in support of registration of the sedum fluoroacetate (compound 1080) livestock protection collar. U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado, USA.

Burns, R. J., G. E. Connolly, and P. J. Savarie. 1990. Day–Glo® fluorescent particles as a marker for use in M–44 cyanide capsules. Proceedings of the Vertebrate Pest Conference 14:281–284.

Burns, R. J., and J. R. Mason. 1996. Effectiveness of vichos non–lethal collars in deterring coyote attacks on sheep. Proceedings of the Vertebrate Pest Conference 17:204–206.

Burns, R. J., D. E. Zemlicka, and P. J. Savarie. 1996. Effectiveness of large livestock protection collars against depredating coyotes. Wildlife Society Bulletin 24:123–127.

Bradley, E. H., D. H. Pletscher, E. E. Bankgs, K. E. Kunkel, D. W. Smith, C. M. Mac, T. J. Meier, J. A. Fontaine, C. C. Neimeyer, and M. D. Jimenez. 2005. Evaluating wolf translocation as a non-lethal method to reduce livestock conflicts in the northwestern United States. Conservation Biology 19:1498–1508.

Breck, S. W., and T. Meier. 2004. Managing wolf depredation in the United States: past, present and future. Sheep and Goat Research Journal 19:41–46.

Bruscino, M. T., and T. L. Cleveland. 2004. Compensation programs in Wyoming for livestock depredation by large carnivores. Sheep and Goat Research Journal 19:47–49.

Cafazzo, S., R. Bonanni, P. Valsecchi, and E. Natoli. 2014. Social variables affecting mate preferences, copulation and reproductive outcome in a pack of free-roaming dogs. PLoS ONE 9: e98594.

California Department of Fish and Game. 1991. Final environmental document, Sections 265, 365, 366, 367, 367.5 Title 14, California Code of Regulations regarding bear hunting. State of California, Department of Fish and Game, Sacramento, California, USA.

Camenzind, F. J. 1978. Behavioral ecology of coyotes on the national Elk Refuge, Jackson, Wyoming. 2001, reprint. Pages 267–265 *in* M. Bekoff, editor. Coyotes: Biology, Behavior and Management. Academic Press, New York, New York, USA.

Caturano, S. L. 1983. Habitat and home range use by coyotes in eastern Maine. Thesis, University of Maine, Orono, Maine, USA.

Cegelski, M. J. 2008. Prevalence of *Toxoplasma gondii* and *Neopora caninum* antibodies in coyotes (*Canis latrans*) from Pennsylvania. Thesis, Shippensburg University, Shippensburg, Pennsylvania, USA.

Chardonnet, P., B. des Clers, J. Fischer, F. Jori, and F. Lamarque. 2002. The value of wildlife. Revue scientifique et technique 21:15–51.

Chen, K. K., and C. L. Rose. 1952. Nitrite and thiosulfate therapy in cyanide poisoning. Journal of the American Medical Association 149:113–119.

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

Collinge, M. D., and C. L. Maycock. 1997. Cost-effectiveness of predator damage management efforts to protect sheep in Idaho. Great Plains Wildlife Damage Control Workshop 13:33–41.

Conner, M. M., M. R. Ebinger, and F. F. Knowlton. 2008. Evaluating coyote management strategies using a spatially explicit, individual-based, socially structured population model. Ecological Modeling 219:234–247.

Conner, M. M., M. M. Jaeger, T. J. Weller, and D. R. McCullough. 1998. Effect of coyote removal on sheep depredations in northern California. Journal of Wildlife Management 62:690–699.

Connolly, G. E. 1980. Use of compound 1080 in livestock neck collars to kill depredating coyotes: a report on field and laboratory research, November 1978–March 1980. U. S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado, USA.

Connolly, G. 1992. Sheep and goat losses to predators in the United States. Proceedings of the Eastern Damage Control Conference 5:75–82.

Connolly, G. 1995. Animal damage control research contributions to coyote management. Pages 61–71 *in* Proceedings of the 1995 Joint Fur Resources Workshop. 4–7 June 1995, Davis, West Virginia, USA.

Connolly, G., and R. J. Burns. 1990. Efficacy of compound 1080 livestock protection collars for killing coyotes that attack sheep. Proceedings of the Vertebrate Pest Conference 14:269–276.

Connolly, G., R. J. Burns, and G. D. Simmons. 1986. Alternate toxicants for the M–44 sodium cyanide ejector. Proceedings of the Vertebrate Pest Conference 12:318–329.

Connolly, G., and W. M. Longhurst. 1975. The effects of control on coyote populations: a simulation model. Bulletin 1872. University of California, Cooperative Extension, Berkeley, California, USA.

Connolly, G., R. M. Timm, W. E. Howard, and W. M. Longurst. 1976. Sheep killing behavior of captive coyotes. Journal of Wildlife Management 40:400–407.

Conover, M. R. 2002. Resolving human-wildlife conflicts: the science of wildlife-damage management. Lewis Publishers, Washington, D.C., USA.

Coolahan, C. 1990. The use of dogs and calls to take coyotes around dens and resting areas. Proceedings of the Vertebrate Pest Conference 14:260–262.

Coppinger, R., J. Lorenz, and L. Coppinger. 1983. Introducing livestock guarding dogs to sheep and goat producers. Proceedings of the Eastern Wildlife Damage Control Conference 1:253–259.

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. Bulletin of Environmental Contamination and Toxicology 63:312–319.

Craven, S., T. Barnes, and G. Kania. 1998. Toward a professional position on the translocation of problem wildlife. Wildlife Society Bulletin 26:171–177.

Cypher, B. L. 2003. Foxes. Pages 511–546 *in* G. A. Feldhamer, B. C. Thompson, and J. A Chapman, editors. Wild Mammals of North America: biology, management and economics, 2nd edition. Johns Hopkins University Press, Baltimore, Maryland, USA.

Davidson-Nelson, S. J., and T. M. Gehring. 2010. Testing fladry as a nonlethal management tool for wolves and coyotes in Michigan. Human-Wildlife Interactions 4:87–94.

Decker, D. J., T. L. Brown, and W. F. Siemer, editors. 2001. Human dimensions of wildlife management in North America. The Wildlife Society, Bethesda, Maryland, USA.

Decker, D. J., and G. R. Goff, editors. 1987. Valuing wildlife: economic and social perspectives. Westview Press. Boulder, Colorado, USA.

Decker, D. J., and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildlife Society Bulletin 16:53–57.

Dorrance, M. J., and J. Bourne. 1980. An evaluation of anti-coyote electric fencing. Journal of Range Management 33:385–387.

Dorrance, M. J., and L. D. Roy. 1976. Predation losses of domestic sheep in Alberta. Journal of Range Management 29:457–460.

Dubey, J. P. 2003. Review of *Neospora caninum* and *neosporosis* in animals. The Korean Journal of Parasitology 41:1–16.

Elfelt, M. 2014. Coyote movement ecology and food habits at Fort Bragg Military Installation. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Environmental Protection Agency (EPA). 1991. Reregistration eligibility document inorganic nitrate/nitride (sodium and potassium nitrates). U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C., USA.

Environmental Protection Agency (EPA). 1994. Reregistration eligibility decision (R.E.D.) Sodium Cyanide. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C., USA.

Environmental Protection Agency (EPA). 1995. Reregistration eligibility decision (R.E.D.) Sodium Fluroacetate. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C., USA.

Environmental Protection Agency (EPA). 2006*b*. Memorandum July 10, 2006: sodium cyanide revised HED risk assessment for tolerance reassessment eligibility decision (TRED) document PC code No. 074002; DP barcode No.318015. Environmental Protection Agency, Washington D.C., USA.

Environmental Protection Agency (EPA). 2006*a*. Memorandum June 29, 2006: revised sodium cyanide reregistration eligibility decision (RED): summary of analytical chemistry and residue data. Environmental Protection Agency, Washington D.C., USA.

Environmental Protection Agency (EPA). 2010. Acute exposure guideline levels (AEGLs) for selected cyanide salts. Environmental Protection Agency, Washington D.C., USA.

Fagerstone, K. A., and G. Keirn. 2012. Wildlife Services – A leader in developing tools and techniques for managing carnivores. Proceedings of the Wildlife Damage Management Conference 14:44–55.

Fagerstone, K. A., L. A. Miller, G. J. Killian, and C. A. Yoder. 2010. Review of issues concerning the use of reproductive inhibitors, with particular emphasis on resolving human-wildlife conflicts in North America. Integrative Zoology 5:15–30.

Faries, F. C. Jr., and L. G. Adams. 1997. Controlling bovine tuberculosis and other infectious diseases in cattle with total health management. Pub B–6051. Texas Agricultural Extension Service, Texas A&M University, Nacadoches, Texas, USA.

Farrar, R. O., N. W. Lafon, G. W. Norman, and D. E. Steffen. 1999. 1998 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Farrar, R. O., G. W. Norman, and D. E. Steffen. 2000. 1999 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Farrar, R. O., G. W. Norman, and D. E. Steffen. 2001. 2000 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Farrar, R. O., G. W. Norman, and D. E. Steffen. 2002. 2001 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Federal Drug Administration (FDA). 2003. Bird poisoning of federally protected birds. Office of Criminal Investigations. Enforcement Story 2003. Washington, D.C., USA.

Fies, M. L. 2006. 2005 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2007. 2006 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2008. 2007 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2009. 2008 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2010*b*. 2009 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2010*a*. Furbearer Investigations: fur buyers survey: July 1, 2009 – June 30, 2010. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2011*a*. 2010 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2011*b*. Furbearer Investigations: fur buyers survey: July 1, 2010 – June 30, 2011. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2012*a*. 2011 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2012*b*. Furbearer Investigations: fur buyers survey: July 1, 2011 – June 30, 2012. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2013*a*. 2012 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2013*b*. Furbearer Investigations: annual report: July 1, 2012 – June 30, 2013. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2014*a*. 2013 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L. 2014*b*. Furbearer Investigations: annual report: July 1, 2013 – June 30, 2014. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L., and G. W. Norman. 2004. 2003 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fies, M. L., and G. W. Norman. 2005. 2004 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Fischer, J., and D. B. Lindenmayer. 2000. An assessment of the published results of animal relocations. Biological Conservation 96:1–11.

Franklin, W. L, and K. J. Powell. 1993. Guard llamas. Iowa state University Extension Bulletin, Ames, Iowa, USA.

Frey, J. K. 2013. Re-evaluation of the evidence for the importation of red foxes from Europe to colonial America: origins of the southeastern red fox (*Vulpes vulpes fulva*). Biological Conservation 158:74–79.

Frair, J., J. Gibbs, G. Batcheller, and P. Jensen. 2014. Progress report: population status and foraging ecology of eastern coyotes in New York State. State University of New York College of Environmental Science and Forestry, Syracuse, New York, USA.

Gee, C. K. 1979. Cattle and calf loses to predators: feeder cattle enterprises in the United States. Journal of Range Management 32:152–154.

Gee, C. K., R. S. Magleby, W. R. Bailey, R. L. Glum, and L. M. Arthur. 1977. Sheep and lamb losses to predators and other causes in the western United States. Agricultural Economic Research Report No. 369. U.S. Department of Agriculture, Economic Research Service, Washington, D.C., USA.

Gehring, T. M., K. C. VerCauteren, and J-M. Landry. 2010. Livestock protection dogs in the 21st century: is an ancient tool relevant to modern conservation challenges? BioScience 60:299–308.

Gese, E. M., and S. Grothe. 1995. Analysis of coyote predation on deer and elk during winter in Yellowstone National Park, Wyoming. American Midland Naturalist 133:36–43.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1988. Coyote group size and diet in southeastern Colorado. Journal of Wildlife Management 52:647–653.

Gese, E. M., and R. L. Ruff. 1997. Scent-marking by coyotes, *Canis latrans*: the influence of social and ecological factors. Animal Behaviour 54:1155–1166.

Gese, E. M., and R. L. Ruff. 1998. Howling by coyotes (*Canis latrans*): variation among social classes, seasons, and pack sizes. Canadian Journal of Zoology 76:1037–1043.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996*a*. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behavior 52:1025–1043.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996*b*. Foraging ecology of coyotes (*Canis latrans*): the influence of extrinsic factors and a dominance hierarchy. Canadian Journal of Zoology 74:769–783.

Ghert, S. D., S. P. D. Riley, and B. L. Cypher, editors. 2010. Urban carnivores: ecology, conflict, and conservation. Johns Hopkins University Press, Baltimore, Maryland, USA.

Gier, H. T. 1968. Coyotes in Kansas (revised), Bulletin 393. Kansas State College of Agriculture and Applied Science, Agricultural Experiment Station, Manhattan, Kansas, USA.

Gondim, L. F., M. M. McAllister, W. C. Pitt, and D. E. Zemlicka. 2004. Coyotes (*Canis latrans*) are definitive hosts of *Neospora caninum*. International Journal for Parasitology 34:159–161.

Gooselink, T. E., T. R. Van Deelen, R. E. Warner, and M. G. Joselyn. 2003. Temporal habitat partitioning and spatial use of coyotes and red foxes in east-central Illinois. Journal of Wildlife Management 67:90–103.

Green, J. S. 1989. Donkeys for predation control. Eastern Wildlife Damage Management Conference 4:83–86.

Green, J. S., and P. S. Gipson. 1994. Feral dogs. Pages C77–81 *in* S. E. Hygnstrom, R. E. Timm, and G. E. Larson, editors. Prevention and Control of Wildlife Damage. University of Nebraska, Lincoln, Nebraska, USA.

Green, J. S., and R. A. Woodruff. 1983. The use of three breeds of dog to protect rangeland sheep from predators. Applied Animal Ethology 11:141–161.

Green, J. S., and R. A. Woodruff. 1999. Livestock guarding dogs: protecting sheep from predators. Agriculture information bulletin number 588. U.S. Department of Agriculture, APHIS, Wildlife Services, Riverdale, Maryland, USA.

Green, J. S., R. A. Woodruff, and T. T. Tueller. 1984. Livestock guarding dogs for predator control: costs, benefits, and practicality. Wildlife Society Bulletin 12:44–45

Harrison, D. J., J. A. Bissonette, and J. A. Sherburne. 1989. Spatial relationships between coyotes and red foxes in eastern Maine. Journal of Wildlife Management 53:181–185.

Henne, D. R. 1975. Domestic sheep mortality on a western Montana ranch. Thesis, University of Montana, Missoula, Montana, USA.

Henne, D. R. 1977. Domestic sheep mortality on a western Montana ranch. Pages 133–134 *in* R. L. Phillips and C. J. Jonkle, editors. Proceedings of the 1975 Predator Symposium. June 16–19, 1975, Missoula, Montana, USA.

Hoffman, R. A., and C. M. Kirkpatrick. 1954. Red fox weights and reproduction in Tippecanoe County, Indiana. Journal of Mammalogy 35:504–509.

Hone, J., and H. Mulligan. 1982. Vertebrate Pesticides. Science Bulletin 89: June 1982. Department of Agriculture, New South Wales, Sydney, Australia.

Hood, G. 2006. Personable pooches. Colonial Williamsburg Journal 28:74–79.

Howard, J. W., and R. F. Hanzal. 1955. Chronic toxicity for rats of food treated with hydrogen cyanide. Journal of Agricultural and Food Chemistry 3:325–329.

Howery, L. D., and T. J. DeLiberto. 2004. Indirect effects of carnivores on livestock foraging behavior and production. Sheep and Goat Research Journal 19:53–57.

Hazardous Substances Data Bank (HSDB). 2015. Sodium cyanide. Database of the National Library of Medicine's TOXNET System [Online]. Bethesda, Maryland, USA. <http://toxnet.nlm.nih.gov.> Accessed 14 May 2015.

Hughes, J., and D. M. Macdonald. 2013. A review of the interactions between free-roaming domestic dogs and wildlife. Biological Conservation 157:341–351.

Hulet, C. V., D. M. Anderson, J. N. Smith, and W. L. Schupe. 1987. Bonding of sheep to cattle as an effective technique for predation control. Applied Animal Behaviour Science 19:19–25.

Hulet, C. V., D. M. Anderson, J. N. Smith, and W. L. Schupe, C. A. Taylor, Jr., and L. W. Murray. 1989. Bonding of goats to sheep and cattle for protection from predators. Applied Animal Behaviour Science 22:261–267.

Jagnow, C. P., J. Howell, and D. E. Steffen. 2009. Virginia Survey of hunter harvest, effort, and attitudes 2008–2009. Wildlife Resource Bulletin No. 09–03. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

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

Kidd, Q., E. Harris, and M. Baer. 2014*a*. Results of the 2013–2014 Virginia hunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA. Wason Center for Public Policy, Christopher Newport University, Newport News, Virginia, USA.

Kidd, Q., E. Harris, and M. Baer. 2014*b*. Results of the 2013–2014 Virginia trapper harvest survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA. Wason Center for Public Policy, Christopher Newport University, Newport News, Virginia, USA.

Kimball, B. A., J. R. Mason, F. S. Blom, J. J. Johnston, and D. E. Zimlicka. 2000. Development and testing of seven new synthetic coyote attractants. Journal of Agriculture and Food Chemistry 48:1892–1897.

Klebenow, D. A., and K. McAdoo. 1976. Predation on domestic sheep in northeastern Nevada. Journal of Range Management 29:96–100.

Kluever, B. M., S. W. Breck, L. D. Howery, P. R. Krausman, and D. L. Bergman. 2008. Vigilance in cattle: the influence of predation, social interactions, and environmental factors. Rangeland Ecology and Management 61:321–328.

Knowlton, F. F., E. M. Gese, and M. M. Jaeger. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52:398–412.

Kreeger, T. J., U. S. Seal, and J. R. Tester. 1990. Pathological responses of red foxes to foothold traps. Journal of Wildlife Management. 54:147–160.

Labisky, R. F., and M. C. Boulay. 1998. Behaviors of bobcats preying on white–tailed deer in the everglades. American Midland Naturalist 139:275–281.

Lafon, N. W., G. W. Norman, D. D. Martin, and D. E. Steffen. 1998. 1997 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Lafon, N. W., R. O. Farrar, G. W. Norman, and D. E. Steffen. 2004. 2002 Virginia bowhunter survey. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Laidlaw, M. A., H. W. Mielke, G. M. Filippelli, D. L. Johnson, and C. R. Gonzales. 2005. Seasonality and children's blood lead levels: Developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana, USA. Environmental Health Perspectives 113:793–800.

Larivière, S., and M. Pasitschniak–Arts. 1996. No. 537: *Vulpes vulpes in* M. J. Hamilton, editor. Mammalian Species. American Society of Mammalogists, Topeka, Kansas, USA.

Laundré, J. W., L. Hernández, and K. B. Altendorf. 2001. Wolves, elk, and bison: reestablishing the "landscape of fear" in Yellowstone National Park, USA. Canadian Journal of Zoology 79:1401–1409.

Lehmkuhler, J., G. Palmquist, D. Ruid, B. Willding, and A. Wydeven. 2007. Effects of wolves and other predators on farms in Wisconsin: beyond verified losses. Wisconsin Department of Natural Resources, Wisconsin Wolf Science Committee, Madison, Wisconsin, USA.

Lehner, P. N., R. Krumm, and A. T. Cringan. 1976. Tests for olfactory repellents for coyotes and dogs. Journal of Wildlife Management 40:145–150.

Linhart, S. B. 1984. Strobe light and siren devices for protecting fenced-pasture and range sheep from coyote predation. Proceedings of the Vertebrate Pest Conference 11:154–156.

Linhart S. B., R. T. Sterner, G. J. Dasch, and J. W. Theade. 1984. Efficacy of light and sound stimuli for reducing coyote predation upon pastured sheep. Protection Ecology 6:75–84.

Linhart, S. B., Dasch, G. J., Johnson, R. R., Roberts, J. D., and C. J Packham. 1992. Electronic frightening devices for reducing coyote depredation on domestic sheep: efficacy under range conditions and operational use. Vertebrate Pest Conference 15:386–392.

Linhart, S. B., J. D. Roberts, and G. J. Dasch. 1982. Electric fencing reduces coyote predation on pastured sheep. Journal of Range Management 35:276–281.

Linzey, D. W. 1998. Mammals of Virginia. McDonald and Woodward, Blacksburg, Virginia, USA.

Littauer, G. A. 1983. Rancher use of compound 1080 toxic collars in New Mexico. Proceedings of the Great Plains Wildlife Damage Control Workshop 6:92–103.

Littin, K. E., C. E. O'Conner, N. G. Gregory, D. J. Mellor, and C. T. Eason. 2002. Behavior, coagulopathy and pathology of brushtail possums (*Trichosurus Vulpecula*) poisoned with brodifacoum. Wildlife Research 29:259–267.

Lloyd, H. G. 1983. The red fox in Britain. Pages 207–215 *in* M. W. Fox, editor. The Wild Canids: their systematics, behavioral ecology and evolution. Robert E. Krieger Publishing Company, Inc., Malabar, Florida, USA.

Lowney, M. S. 1999. Damage by black and turkey vultures in Virginia, 1990–1996. Wildlife Society Bulletin 27:715–719.

Major, J. T., and J. A. Sherburne. 1987. Interspecific relationships of coyotes, bobcats, and red foxes in western Maine. Journal of Wildlife Management 51:606–616.

Material Safety Data Sheet (MSDS). 2005. Fatty Acid Scent (FAS), an EPA non-registered material. Pocatello Supply Depot, Pocatello, Idaho, USA.

Mattchett, M. R., S. W. Breck, and J. Callon. 2013. Efficacy of electronet fencing for excluding coyotes: a case study for enhancing production of black-footed ferrets. Wildlife Society Bulletin 37:893–900.

McAdoo, J. K., and D. A. Klebenow. 1978. Predation on range sheep with no predator control. Journal of Range Management 31:111–114.

McAllister, M. M. 1999. Uncovering the biology and epidemiology of *Neospora caninum*. Parasitology Today 15:216–217.

McDonald, D. M. 1976. Food caching by red foxes and some other carnivores. Zeitschrift für Tierpsychologie 42:170–185.

McEneaney, T. P., and M. A. Jenkins. 1983. Bald eagle predation on domestic sheep. Wilson Bulletin 95:694–695.

Mason, J. R., and L. Clark. 1997. Avian repellents: opinions, modes of action, and economic considerations. Pages 371–391 *in* J. R. Mason, editor. Repellents in Wildlife Management: proceedings of a Symposium. Proceedings of the second DWRC Special Symposium, August 8–10, 1995, Fort Collins, Colorado, USA.

Mason, J. R., J. A. Shivik, and M. W. Fall. 2001. Chemical repellents and other aversive strategies in predation management. Endangered Species UPDATE 18:175–181.

Massei, G., and L. A. Miller. 2013. Nonsurgical fertility control for managing free-roaming dog populations: a review of products and criteria for field applications. Theriogenology 80:829–838.

Mastro, L. L. 2011. Life history and ecology of coyotes in the mid-Atlantic states: a summary of the scientific literature. Southeastern Naturalist 10:721–730.

Mastro, L. L., E. M. Gese, J. K. Young, and J. A. Shivik. 2012. Coyote (*Canis latrans*), 100^{+} years in the east: a literature review. Addendum to the Proceedings of the 14^{th} Wildlife Damage Management Conference.

Meadows, L. E., and F. F. Knowlton. 2000. Efficacy of guard llamas to reduce canine predation on domestic sheep. Wildlife Society Bulletin 28:614–622.

Mech, L. D., E. K. Harper, T. J. Meier, and W. J. Paul. 2000. Assessing factors that may predispose Minnesota farms to wolf depredations on cattle. Wildlife Society Bulletin 28:623–629.

Meduna, R. L. 1977. Relationships between sheep management and coyote predation. Thesis, Kansas State University, Manhattan, Kansas, USA.

Mettler, A. E., and J. A. Shivik. 2007. Dominance and neophobia in coyote (*Canis latrans*) breeding pairs. Applied Animal Behaviour Science 102:85–94.

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.

Moore, G. C., and G. R. Parker. 1992. Colonization by the eastern coyote *(Canis latrans)*. Pages 23–38 *in* Boer, A. H., editor. Ecology and management of the eastern coyote. Wildlife Research Unit, University of New Brunswick, Fredericton, New Brunswick, Canada.

Muhly, T. B., M. Alexander, M. S. Boyce, R. Creasey, M. Hebblewhite, D. Paton, J. A. Pitt, and M. Musiani. 2010. Differential risk effects of wolves on wild versus domestic prey have consequences for conservation. Oikos 119:1243–1254.

Nass, R. D. 1977. Mortality associated with sheep operations in Idaho. Journal of Range Management 30:253–258.

Nass, R. D., and J. Theade. 1988. Electric fences for reducing sheep losses to predators. Journal of Range Management 41:251–252.

National Agricultural Statistics Service (NASS). 1991. Sheep and goat predator loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 1992. Cattle and calves death loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 1995. Sheep and goat predator loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 1996. Cattle predator loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2000. Sheep and goats predator loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2001. Cattle predator loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2005. Sheep and goats death loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2006. Cattle death loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2009. Sheep and Goats. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2010. Sheep and goats death loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2011. Cattle death loss. United States Department of Agriculture, Washington, D.C., USA.

National Agricultural Statistics Service (NASS). 2014. 2012 census of agriculture: Virginia State and County Data. United States Department of Agriculture, National Agricultural Statistics Service,

Washington, D.C., USA. <http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_State_Level/Virginia/vav1.pdf> Accessed 9 March 2015.

National Audubon Society. 2010. The Christmas Bird Count Historical Results [Online]. New York, New York, USA. <http:www.audubon2.org/cbchist/table.html>. Accessed 9 March 2015.

Neale, J. C. C., B. N. Sacks, M. M. Jaeger, and D. M. McCullough. 1998. A comparison of bobcat and coyote predation on lambs in north–coastal California. Journal of Wildlife Management 62:700–706.

Nielsen, L. 1988. Definitions, considerations, and guidelines for translocation of wild animals. Pages 12–51 *in* L. Nielsen and R. D. Brown, editors. Translocation of wild animals. Wisconsin Humane Society Inc., Milwaukee, Wisconsin, USA and Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA.

Nunley, G. 2004. The coyote on the Edwards plateau of Texas: an update. Sheep and Goat Research Journal 19:23–28.

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.

O'Gara, B. W., and W. Rightmire. 1987. Wolf, golden eagle, and coyote problems in Montana. Eastern Wildlife Damage Management Control Conference 3:275–283.

Osugi, P. O. 1974. The physiology of eating and the energy expenditure of the ruminant at pasture. Journal of Range Management 27:437–443.

Pal, S. K. 2001. Population ecology of free-ranging urban dogs in West Bengal, India. Act Theriologica 46:69–78.

Parker, G. E. 1995. Eastern coyote: the story of its success. Nimbus, Halifax, Nova Scotia, Canada.

Pearson, E. W., and M. Caroline. 1981. Predator control in relation to livestock losses in central Texas. Journal of Range Management 34:425–441.

Phillips, R. L., and R. H. Schmidt. 1994. Foxes. Pages C83–88 *in* S. E. Hygnstrom, R. E. Timm, and G. E. Larson, editors. Prevention and Control of Wildlife Damage. University of Nebraska, Lincoln, Nebraska, USA.

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. Endangered Species UPDATE 18:103–106.

Poole, D. W., and I. G. McKillop. 2002. Effectiveness of two types of electric fence for excluding the red fox (*vulpes vulpes*). Mammal Review 32:51–57.

Ramler, J. P., M. Hebblewhite, D. Kellenberg, and C. Sime. 2014. Crying wolf? A spatial analysis of wolf location and depredations on calf weight. American Journal of Agricultural Economics 96:631–656.

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.

Robley, A., D. Purdey, M. Johnston, M. Lindeman, F. Busana, and K. Long. 2007. Experimental trials to determine effective fence designs for feral cat and fox exclusion. Ecological Management & Restoration 8:193–198.

Root Kustritz, M. V. 2006. The dog breeder's guide to successful breeding and health management. Elsevier Inc., St. Louis, Missouri, USA.

Roughton, R. D. 1982. A synthetic alternative to fermented egg as a canid attractant. Journal of Wildlife Management 46:230–234.

Rosatte, R. C. 2002. Long distance movement by a coyote, *Canis latrans* and red fox, *vulpes vulpes*, in Ontario: implications for disease-spread. Canadian Field-Naturalist 116:129–131.

Sacks, B. N., K. E. Blejwas, and M. M. Jaeger. 1999*a*. Relative vulnerability of coyotes to removal methods on a northern California ranch. Journal of Wildlife Management 63:939–949.

Sacks, B. N., M. M. Jaeger, J. C. C. Neale, and D. R. McCullough. 1999*b*. Territorial and breeding status of coyotes relative to sheep predation. Journal of Wildlife Management 63:593–605.

Sacks, B. N., and J. C. C. Neale. 2002. Foraging strategies of a generalist predator toward a special prey: coyote predation on sheep. Ecological Applications 12:299–306.

Sacks, B. N., and J. C. C. Neale. 2007. Coyote abundance, sheep predation, and wild prey correlates illuminate Mediterranean tropic dynamics. Journal of Wildlife Management 71:2404–2411.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski Jr., and W. A. Link. 2014. The North American Breeding Bird Survey, Results and Analysis 1966–2012. Version 01.30.2015 USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA. <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>. Accessed 5 May 2015.

Savarie, P. J., and M. V. Garrison. 1976. Chemical stability of sodium cyanide (NaCN) in M-44 cyanide capsules. Pages 10–53 *in* R. D. Thompson. Denver Wildlife Research Center Section of Supporting Sciences: 1976 annual progress report. U.S. Department of the Interior, U.S. Fish and Wildlife Service, division of Wildlife Research, Denver, Colorado, USA.

Schaefer, J. M. 1978. Coyote and dog depredation on sheep in southern Iowa. Thesis, Iowa State University, Ames, Iowa, USA.

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.

Schafer, E. W., Jr., 1990. Letter from Edward Schafer, U.S. Department of Agriculture, to Yvonne Brown, U.S. Environmental Protection Agency, Dated February 28, 1990, Phase 2 Response-List C Case #3086, Chemical #74002 – inorganic cyanide waiver request (low volume-minor use) revised commitment page.

Schmidt, R. 1989. Animal welfare and wildlife management. Transactions North American Wildlife and Natural Resource Conference 54:468–475.

Schofield, R. D. 1958. Litter size and age ratios of Michigan red foxes. Journal of Wildlife Management 22:313–315.

Schrecengost, J. D. 2007. Home range and food habits of the coyote (*Canis latrans*) at the Savannah River site, South Carolina. Thesis, University of Georgia, Athens, Georgia, USA.

Scott, M. D., and K. Causey. 1973. Ecology of feral dogs in Alabama. Journal of Wildlife Management 37:253–265.

Scrivner, J. H., D. A. Wade, G. H. Connolly, and L. C. Howard Jr. 1985. Cost and other effects of predation on an angora goat ranch. Rangelands 7:54–57.

Seddon, P. J., W. M. Strauss, and J. Innes. 2012. Animal translocations: what are they and why do we do them? Pages 1–32 *in* Ewen, J.G., D. P. Armstrong, K. A. Parker and P. J. Seddon, Editors. Reintroduction Biology: Integrating Science and Management, John Wiley and Sons, Ltd., Oxford, United Kingdom.

Sevi, A., D. Casamassima, and A. Muscio. 1999. Group size effects on grazing behavior and efficiency in sheep. Journal of Range Management 52:327–331.

Shelton, M. 2004. Predation and livestock production: perspective and overview. Sheep and Goat Research Journal 19:2–5.

Sheldon, W. G. 1949. Reproductive behavior of foxes in New York State. Journal of Mammalogy 30:236–246.

Shivik, J. A., M. M. Jaeger, and R. H. Barrett. 1996. Coyote movements in relation to the spatial distribution of sheep. Journal of Wildlife Management 60:422–430.

Shivik, J. A., and D. J. Martin. 2001. Aversive and disruptive stimulus applications for managing predation. Proceedings of the Wildlife Damage Management Conference 9:111–119.

Shivik, J. A., D. J. Martin, M. J. Pipas, J. Turnan, and T. J. DeLiberto. 2005. Initial comparison: jaws, cables, and cage-traps to capture coyotes. Wildlife Society Bulletin 33:1375–1383.

Shivik, J. A., L. Mastro, and J. K. Young. 2014. Animal attendance at M-44 sodium cyanide ejector sites for coyotes. Wildlife Society Bulletin 38:217–220.

Shivik, J. A., A. Treves, and P. Callahan. 2003. Nonlethal techniques for managing predation: primary and secondary repellents. Conservation Biology 17:1531–1537.

Shivik, J. A., R. R. Wilson, and L. Gilbert-Norton. 2011. Will an artificial scent boundary prevent coyote intrusion? Wildlife Society Bulletin 35:494–497.

Silver, H., and W. T. Silver. 1969. Growth and behavior of the coyote-like canid of northern New England with observations on canid hybrids. Wildlife Monographs 17:1–41.

Slate, D. A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Transactions of the North American Wildlife and Natural Resources Conference 57:51–62.

Stansley W., L. Widjeskog, and D. E. Roscoe. 1992. Lead contamination and mobility in surface water at trap and skeet ranges. Bulletin of Environmental Contamination and Toxicology 49:640–647.

Statham, M. J., B. N. Sacks, K. B. Aubry, J. D. Perrine, and S. M. Wisely. 2012. The origin of recently established red fox populations in the United States: translocations or natural range expansion. Journal of Mammalogy 93:52–65.

Sterner, R. T. 1979. Effects of sodium cyanide and diphacionone in coyotes (*Canis latrans*): applications as predacides in livestock toxic collars. Bulletin of Environmental Contamination and Toxicology 23:211–217.

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.

Switzenberg, D. F. 1950. Breeding productivity in Michigan red foxes. Journal of Mammalogy 31:194–195.

Thompson, B. C. 1979. Evaluation of wire fences for coyote control. Journal of Range Management 32:457–461.

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.

Timm, R. M. 1994. Sodium cyanide. Page G48 *in* S. E. Hygnstrom, R. E. Timm, and G. E. Larson, editors. Prevention and Control of Wildlife Damage. University of Nebraska, Lincoln, Nebraska, USA.

Timm, R. M., and G. E. Connolly. 1980. How coyotes kill sheep. National Wool Grower 70:14–15.

Turkowski, F. J., M. L. Popelka, and R. W. Bullard. 1983. Efficacy of odor lures and baits for coyotes. Wildlife Society Bulletin 11:136–145.

U.S. Department of Agriculture (USDA). 2002*a*. Environmental assessment for the management of coyote, dog, and red fox predation on livestock in the Commonwealth of Virginia. U.S. Department of Agriculture, APHIS, WS, Moseley, Virginia, USA.

U.S. Department of Agriculture (USDA). 2002*b*. The electronic guard: a tool in predation control. Factsheet. U.S. Department of Agriculture, APHIS, WS, Washington D.C., USA.

U.S. Department of Agriculture (USDA). 2010. M-44 device for local predator control. Factsheet. U.S. Department of Agriculture, APHIS, WS, Washington D.C., USA.

U.S. Department of Agriculture (USDA). 2007. Decision and finding of no significant impact: environmental assessment for the management of coyote, dog, and red fox predation on livestock in the Commonwealth of Virginia. U.S. Department of Agriculture, APHIS, WS, Moseley, Virginia, USA.

U.S. Fish and Wildlife Service (USFWS). 1978. Predator damage in the west: a study of coyote management alternatives. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA.

U.S. Fish and Wildlife Service (USFWS). 1975. Section J: Hazards to the Environment. Pages 96–102 *in* A petition proposing the registration of M-44 cyanide capsules as a predacide for reducing the number of coyotes (*Canis latrans*), red fox (*vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), and feral dogs (*Canis familares*) causing livestock depredations, damage to wildlife, or serving as disease vectors on rangelands, pasture, and forest lands in the Western United States. Unpublished report. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA.

U.S. Fish and Wildlife Service (USFWS). 2001. Ohio man to pay more than $11,000 for poisoning migratory birds. Inside Region 3: An information product from the Accomplishment Reporting System, Volume 4, No. 2, 10 December 2001:5.

U.S. Fish and Wildlife Service (USFWS). 2007. National Bald Eagle Guidelines. U.S. Fish and Wildlife Service, Washington, D.C., USA. <http://www.fws.gov/midwest/eagle/pdf/NationalBaldEagleManagementGuidelines.pdf.> Accessed 13 May 2015.

U.S. Fish and Wildlife Service (USFWS). 2009. Final environmental assessment: proposal to permit take as provided under the bald and golden eagle protection act. U.S. Fish and Wildlife Service, Washington, D.C., USA.

U.S. Fish and Wildlife Service (USFWS). 2012. Permits for Non-Purposeful Take of Eagles. <http://www.fws.gov/midwest/MidwestBird/EaglePermits/baeatakepermit.html>. Accessed 13 May 2015.

VerCauteren, K. C., M. J. Lavelle, and S. Moyles. 2003. Coyote-activated frightening devices for reducing sheep predation on open range. Proceedings of the Wildlife Damage Management Conference 10:146–151.

Virginia Department of Agriculture and Consumer Services (VDACS). 2015. Office of the State Veterinarian, Online Animal Reporting Public Search Database. <https://arr.va-vdacs.com/cgi-bin/Vdacs_search.cgi.> Accessed 30 January 2015.

Virginia Department of Game and Inland Fisheries (VDGIF). 2010. 2009–2010 hunter survey report [DRAFT]. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Virginia Department of Game and Inland Fisheries (VDGIF). 2012. 2011–2012 hunter survey report [DRAFT]. Virginia Department of Game and Inland Fisheries, Richmond, Virginia, USA.

Voigt, D. R. 1987. Red fox. Pages 378–392 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, editors. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Ontario, Canada.

Wade, D. A., and J. E. Bowns. 1982. Procedures for evaluating predation on livestock and wildlife. Texas A&M University, Texas Agricultural Experiment Station and Texas Agricultural Extension, College Station, Texas, USA.

Wagner, F. H. 1988. Predator control and the sheep industry: the role of science in policy formation. Regina Books, Claremont, California, USA.

Wagner, F. H., and L. G. Pattison. 1973. Analysis of existing data on sheep loss and predator activity. Pages 18–35 *in* F. H. Wagner, editor. Final Report to the Four Corners Regional Commission on Predator Control Study, Contract FCRC No. 621–366–044. Utah State University, Logan, Utah, USA.

Walton, M. T., and C. A. Field. 1989. Use of donkeys to guard sheep and goats in Texas. Proceedings of the Eastern Wildlife Damage Control Conference 4:87–94.

Ward, J. C., and D. A. Spencer. 1947. Notes on the pharmacology of sodium fluoroacetate-compound 1080. Journal of the American Pharmaceutical Association 36:59–62.

White, D. H., L. E. Hayes, and P. B. Bush. 1989. Case histories of wild birds killed intentionally with famphur in Georgia and West Virginia. Journal of Wildlife Diseases 25:144–188.

Wiemeyer, S. N., E. F. Hill, J. W. Carpenter, and A. J. Krynitsky. 1986. Acute oral toxicity of sodium cyanide in birds. Journal of Wildlife Diseases 22:538–546.

Windberg, L. A., F. F. Knowlton, S. M. Ebbert, and B. T. Kelly. 1997. Aspects of coyote predation on Angora goats. Journal of Range Management 50:226–230.

Witmer, G., A. Hayden, and M. Pipas. 1993. Predator depredations on sheep in Pennsylvania. Proceedings Eastern Wildlife Damage Control Conference 6:194–200.

Yeates, J. W. 2010. Death is a welfare issue. Journal of Agricultural & Environmental Ethics 23:229–241.

APPENDIX B: METHODS AVAILABLE FOR PREVENTING, REDUCING AND ELIMINATING DAMAGE AND THREATS TO LIVESTOCK ASSOCIATED WITH COYOTE, DOG AND RED FOX IN THE COMMONWEALTH OF VIRGINIA

A variety of methods are potentially available to the WS program in Virginia. Various federal, Commonwealth, and local statutes and regulations and WS Directives govern WS' use of these methods. The following methods and materials may be recommended or used in technical assistance and direct damage management efforts of the WS program in Virginia. Not all methods would be considered effective, efficient, practical, or legal in every situation and may not be recommended or utilized.

NON-LETHAL METHODS (NON-CHEMICAL)

RESOURCE MANAGEMENT

Resource management includes a variety of practices that may be used by resource owners or managers to reduce the potential for wildlife damage. Implementation of these practices is appropriate when the potential for damage can be reduced without substantially increasing a resource owner's costs or diminishing their ability to manage resources pursuant to goals. Resource management recommendations are made through WS technical assistance efforts.

Animal Husbandry: This category includes modifications in the level of care and attention given to livestock, selection of livestock type or breed, shifts in the timing or location of breeding and births, and introduction of human custodians. The level of attention given to livestock varies. Generally, when the frequency and intensity of livestock handling increases, so does the degree of protection.

Altering animal husbandry to reduce wildlife damage has many limitations. For example, confinement may not be possible when grazing conditions require livestock to scatter. Hiring extra people, building secure holding pens, and adjusting the timing of births is usually expensive. The expense associated with a change in husbandry practice may exceed the savings. WS encourages resource owners to use these strategies where they may be beneficial, but does not conduct direct operational assistance.

> ***Selection of Livestock Type, Breed, or Both*:** In areas where damage occurs, the selection of less vulnerable types of livestock (e.g. cows vs. sheep) may reduce the risk of predation. Similarly, the selection of a particular breed of livestock over another may reduce the risk of predation.
>
> ***Scheduling*:** The risk of predation to livestock diminishes with age and increase in size. Shifts in breeding schedules can reduce the risk of predation by altering the timing of births to coincide with the greatest availability of natural food items for predators or to occur out of sync with times in which predators have the greatest need for food items (e.g. when young are present). Adjusting the timing of births is usually expensive. The timing of births may be related to weather or seasonal marketing of livestock.
>
> ***Selective Pasturing:*** Moving livestock to locations where predation has historically been low during times when livestock is most vulnerable (e.g. during birthing).
>
> ***Confinement During Birthing:*** The risk of predation is usually greatest with immature livestock, and females giving birth. This risk can be reduced by holding pregnant females and newborns in pens or sheds.
>
> ***Sanitation:*** Disposal of dead livestock so that it cannot serve as an attractant to predators.

Herders / Monitoring: Herding generally refers to the use of human custodians who stay with livestock day and night for the purpose of moving animals between large, often unfenced, pastures. The presence of herders or alternatively, frequent and close monitoring of livestock may alert owners or managers to signs of damage sooner than infrequent monitoring may.

Habitat Management: Localized habitat management is often an integral part of wildlife damage management but has limited application in most livestock predation situations. In general, the type, quality, and quantity of habitat are directly related to the species of wildlife in an area. Therefore, it is possible to manage habitat in a way that discourages its use by specific species. For example, thick vegetation can be pruned or cleared to eliminate denning and loafing sites or areas where predators can observe or stalk livestock from while remaining out of site. This vegetation may also serve as areas to feed on or cache (hide food for future consumption) livestock carcasses. Additionally, palatable vegetation (e.g. apple trees) which may serve as an attractant can be removed to make an area less attractive. The limitations of habitat management as a method of reducing wildlife damage are determined by the characteristics of the species involved, the nature of the damage, economic feasibility, and other factors. Legal constraints may also exist which preclude altering particular habitats. In most cases, the resource or property owner or manager is responsible for implementing habitat modifications, and WS only provides advice on the type of modifications that have the best chance of achieving the desired effect.

Modification of Human Behavior: Altering human behavior may resolve conflicts between humans and animals. For example, those people who are experiencing damage to livestock associated with unknown dogs can confine or restrain their own dogs (which may or may not be responsible for killing livestock) in order to determine if their dog may be responsible. Those persons experiencing damage can also speak to local animal control or law enforcement authorities with jurisdiction over dog control to change the behavior of other persons. The Commonwealth of Virginia allows localities to prohibit dogs from running at large (Code of Virginia § 3.2-6538). Similarly, eliminating the feeding of wildlife and free-ranging or feral animals may reduce the presence of animals in a given area and with it the damage occurring. This includes the inadvertent feeding allowed by improper disposal of garbage or leaving pet food outdoors where other animals can consume it. In Virginia, it is illegal for any person to place, distribute, or allow the placement of food, minerals, carrion, trash, or similar substances when it attracts any species of wildlife in such numbers or circumstances to cause property damage, endanger any person or wildlife, or create a public health concern (4 VAC 14-40-286). The public does not always comply with laws and ordinances and these statutes must be enforced to be effective.

PHYSICAL EXCLUSION

Physical exclusion methods restrict the access of predators to livestock. These methods can provide effective prevention of damage in many situations. However, exclusionary devices which are 100% effective at excluding predators can be more costly than the value of the livestock being protected, especially for large areas, and, therefore, uneconomical and not often used. In addition, some exclusionary devices require labor intensive maintenance which can further reduce their cost-effectiveness.

Confinement: Livestock can be confined to barns, sheds or other structures when the risk of predation is greatest (e.g. night). Mesh wire hutches, cages or aviaries can provide similar protection from coyote, dog or red fox predation. Mesh with openings of 3 inches or less is recommended to exclude red foxes (Phillips and Schmidt 1994).

Barriers: Cliff faces, bodies of water, the wall of a barn and a variety of other natural and manmade structures provide a barrier to predator movements and restrict access to livestock. Used in conjunction with proper fencing these barriers can be effective.

Conventional Fencing: Fences, either temporary or permanent, can be effective in excluding predators. With any type of fencing the height of the fence must be tall enough, the distance between the fence and the ground and the distance between wires must be small enough to exclude predators and must be maintained because predators are quick to exploit gaps. If motivated, coyote, dog and red fox are able to climb over, jump over, dig under or pass through many fences. For this reason, barbed wire, board, cable wire and non-electrified high-tensile fences are generally not effective at excluding predators. Woven wire fences are generally four feet tall and may have barbed wire along the bottom or top to deter animals from climbing over or digging under it. This type of fence, although not predator proof, when properly installed and maintained is predator resistant. (e.g. Mesh must be kept stretched tight, mesh attached securely to posts, mesh placed tight to the ground (Acorn 1997)). Gates reinforced with fencing or panels which leave minimal gaps when closed or incorporate sills ensure the integrity of woven wire fence. Fences that are 5.5 feet high with overhangs at the top and aprons at the bottom which project at least 15 inches and are composed of mesh no larger than 4 by 5 inches have experimentally been shown to exclude almost 100% of coyotes tested (Thompson 1979). Similarly, a 6 feet high fence with an overhang and apron experimentally excluded red foxes (Robley et al. 2007). However, near predator proof fencing would likely be more costly than the value of the livestock being protected, especially for large areas, require labor intensive maintenance and, therefore, not be feasible for use in most situations.

Electric Fencing: Electric fences can be built for temporary or permanent use. Temporary electric fences can be constructed of polywire, poly tape or ElectroNet^{TM}. Permanent fences can be constructed with either multiple single strand wires or a combination of woven wire or wire mesh and single strand wires. Many authors have studied the ability of electric fences to protect sheep from coyotes (Thompson 1979, Dorrance and Bourne 1980, Linhart et al. 1982, Nass and Theade 1988, Acorn and Dorrance 1994) or other prey from coyotes (Matchett et al. 2013). In general, these studies found electric fencing to be effective at reducing predation but no fence was 100% effective at excluding all coyotes because animals that were willing to expose themselves to electric shock, could avoid electric wires while passing through, digging under or jumping over fences or exploiting times when the fence wasn't charged rendered the fencing ineffective. Similarly, red foxes will continually test electric fences after receiving electric shocks (Poole and McKillop 2002, Robley et al. 2007). Limits of this application include the ability to erect, electrify and maintain electricity to the fence, keep the wires free from contact with vegetation, and test the fence regularly.

Fladry*:* Fladry is a barrier technique that attaches small pieces of flagging to either a temporary or permanent electrified or un-electrified fencing. The movement of the flags in the wind makes a visual barrier which acts as a deterrent. Although effective with other species, and temporarily able to deter dominant coyotes and the vast majority of subordinate coyotes in a controlled environment (Mettler and Shvik 2007), fladry did not deter coyotes from pastures with livestock in Michigan (Davidson-Nelson and Gehring 2010).

FRIGHTENING DEVICES OR DETERRENTS

Frightening devices are used to repel animals from areas where they are causing damage or posing threats of damage. The success of frightening methods depends on an animal's fear of, and subsequent aversion to, offensive stimuli (Shivik and Martin 2001). A persistent effort is usually required to effectively apply frightening techniques and the techniques must be sufficiently varied to prolong their effectiveness. Over time, animals often habituate to commonly used scare tactics and ignore them. The time it takes for animals to habituate can generally be lengthened by using devices which are random or animal activated.

As with other methods, these techniques tend to be more effective when used as part of an integrated management program.

Physical Human and Vehicle Harassment or Hazing: Physical human harassment or hazing involves people pursuing animals on foot, clapping their hands, or shouting. Vehicle harassment involves people pursuing animals with non-motorized or motorized vehicles. These techniques can be used in conjunction with other methods to disperse animals from areas where they cause damage or threats.

Acoustic Stimuli: This category includes using a variety of noise making devices including but not limited to car horns, air horns, stereo systems, radios, bioacoustics, ultrasonic devices, propane exploders, pyrotechnics etc. The effectiveness of noise on predators is generally limited because animals become accustomed to and learn to ignore them. It must be noted that sound-scare devices can also scare people, livestock or non-target wildlife when they are used in their vicinity.

> ***Livestock Bells:*** Some sheep producers place bells on collars around the necks of some of or all of their sheep to deter predators. When studied, no conclusive answers were drawn as to their effectiveness (Meduna 1977).

Visual Stimuli: Different types of lights such as floodlights, strobe lights, lasers, revolving units, and placing vehicles in pastures have been used with mixed results to frighten livestock predators (Meduna 1977, Schaefer 1978). In general, the type of light, the number of units, and their location are determined by the size of the area to be protected and by the power sources available. However, most animals rapidly become accustomed to such lights and they are not generally effective in the long-term. Motion-sensing lights or other visual stimuli may delay habituation.

Other Stimuli: Repellants are substances used to discourage or disrupt particular behavior and are effective because they are irritating, cause sickness or stimulate fear (Mason and Clark 1997). Bone tar oil, predator urine, pepper and other similar substances have been used in an effort to deter predators. In experimental trials, coyote urine did not repel but rather attracted other coyotes (Shivik et al. 2011). Unfortunately, there are no known repellants that are not either both irritating to coyotes, dogs or red foxes and livestock (Lehner et al. 1976, Mason et al. 2001) or stimulate fear in coyotes, dogs or red foxes after repeated exposure (Mason et al. 2001, Shivik et al. 2011). Bone tar oil, predator urine, pepper and other similar substances are non-restricted substances available for use by the public.

Devices Using Multiple Stimuli: One device which uses multiple stimuli is called the electronic guard. It is a frightening device composed of a blinking strobe and a siren which are activated by a timer and a light sensor. When operational the device automatically turns on at sunset and randomly flashes and omits sound for a few seconds at several minute intervals throughout the night, automatically turning off at sunrise (USDA 2002b). The device was designed specifically to reduce coyote predation on livestock (Linhart 1984, Linhart et al. 1984, Linhart et al. 1992). Another device consists of an illuminated pop-up scarecrow and a CD player with audio tracks likely to elicit fear (e.g. aggressively barking dogs, shotgun barrages) and designed to frighten coyotes when activated when infrared beams set at the chest level of a coyote were broken (VerCauteren et al. 2003). A similar device, the movement-activated guard uses a strobe light and recorded sound effects to disperse predators when activated by movement (Shivik et al. 2003). These and other similar devices can be temporarily effective in reducing predation in some situations.

Projectiles: Different types of projectiles (water from a hose, paint balls, sticks, small rocks etc.) may be used to frighten predators. These techniques can be used in conjunction with other methods to disperse animals from areas where they cause damage or threats.

Guard Animals: This method involves pasturing dogs, donkeys or llamas with sheep or goats and in some cases cattle for the purpose of reducing damage or threats from predators. In general, the effectiveness of the method is dependent upon the individual guard animal, the individual predator and the number of livestock being guarded. Effectiveness is improved when used in conjunction with other methods (Walton and Field 1989).

Dogs: Specific breeds of dogs have been developed through selective breeding to bond, live with and protect livestock (Green and Woodruff 1999, Gehring et al. 2010). Livestock guard dogs or livestock protection dogs provide protection by living with the flock at all times, alerting livestock to the presence of predators, pursuing and in some cases actively engaging with the predator (Green and Woodruff 1983). Numerous studies have found that guard dogs are an effective method for reducing predation (Andelt 1992, Coppinger et al. 1983, Green et al. 1984, Andelt and Hopper 2000). Care should be taken when selecting and training a guard dog to maximize the likelihood that the dog will be successful (Green and Woodruff 1999). Successful rearing includes minimal human contact from an early age to ensure dogs form social bonds with livestock and monitoring to ensure bad habits are not developed (e.g. harassment of livestock which results in injury or death of livestock, dog does not stay with livestock, dog is overly aggressive towards people). Not all dogs are effective. Employment of guard dogs is incompatible with several other methods (e.g. snares, M-44s) unless the dogs are properly restricted or trained. WS would be cautious when working near or around guard dogs to minimize potential hazards from methods in compliance with WS Directive 2.440. Dogs require regular care and maintenance.

Donkeys: Donkeys have been used as guard animals because of their natural tendencies to be territorial and aggressive towards canines (Green 1989). Because of these tendencies, they will vocalize loudly, charge, chase and also kick or bite canids (Green 1989, Walton and Field 1989). Single donkeys or a jenny with its foal should be used and they should be isolated from horses and mules to increase the likelihood that they will bond with and travel with the other livestock (Green 1989, Walton and Field 1989). Intact males may be aggressive towards livestock and are not preferred guard animals (Green 1989, Walton and Field 1989). Not all donkeys will confront canines and some may ignore threats not directed at them. Donkeys have similar feeding and maintenance requirements as the livestock they are protecting.

Llamas: Llamas, like donkeys have a natural tendency to aggressively pursue canids (Andelt 2004). Llamas will vocalize, charge, chase or kick canids and position themselves between the canid and the livestock (Andelt 2004). Single llamas are more effective than multiple llamas because of an increased likelihood they will bond and stay with the other livestock. Llamas have similar requirements as the livestock they are protecting. Care should be taken with intact males. Franklin and Powell (1993) reported that fewer sheep were killed annually than after producers acquired a llama. Meadows and Knowlton (2000) reported that livestock producers with llamas lost significantly fewer sheep than livestock producers without in the first year but this difference was not observed in the second year.

Mixed Species Grazing: Pasturing sheep which have been bonded to cattle with cattle has been shown to reduce predation by coyotes (Anderson et al. 1987, Hulet et al. 1987, Hulet et al. 1989). Additionally, pasturing goats, sheep and cattle together when these animals have formed bonds so that they stay together has been shown to reduce predation by coyotes (Hulet et al. 1989). Mature sheep and cattle usually graze separately but young lambs placed with cows soon form bonds, traveling and grazing together (Hulet et al. 1987). Although young goats do not bond tightly with cattle, young goats do bond well with sheep and travel and graze with sheep that are traveling and grazing with heifers (Hulet et al. 1989). Although cattle are predated by coyotes and other

canids, predation levels on cows is much lower than that of sheep and goats (see Chapter 1). The presence of cattle may be adequate to deter some coyotes and act as a predation deterrent.

CAPTURE WITH LIVE CAPTURE DEVICES

Coyotes, dogs and red foxes can be live captured through the use of several methods listed and described in detail below. Upon capture, coyotes and red fox could be relocated or euthanized. However, in most situations coyotes and red foxes captured in live traps are subsequently euthanized (see lethal methods). For discussion of why coyotes and red foxes are not generally relocated see section 3.2. Coyote and red fox are managed by the VDGIF and translocation of coyotes and red foxes could only occur under the authority of the VDGIF. Dogs are managed by local law enforcement and animal control authorities. Owned dogs captured by WS must be returned to their owners or transferred to animal control authorities immediately (WS Directive 2.340(a)). Feral dogs (ownerless or homeless wild dog) captured unintentionally by WS and uninjured will be transferred to animal control authorities or released onsite (WS Directive 2.340(a)). Feral dogs captured unintentionally by WS and injured will be transferred to animal control authorities (WS Directive 2.340(a)). WS would use capture devices in compliance with applicable federal, state and local laws and regulations (WS Directive 2.210) as well as WS Directives to reduce risks to persons, dogs, stock or fowl.

Hand Capture: Hand capture involves using hands to take hold of an animal.

Hand Nets: Hand nets are used to catch animals in confined areas. These nets resemble fishing dip nets with the exception that they are larger and have long handles.

Cage Traps: The most commonly known cage traps used are box traps. Box traps are usually rectangular, and are made from wood or heavy gauge wire mesh. These traps are used to capture animals alive and can often be used where many lethal or more dangerous tools would be too hazardous. Traps are baited with foods attractive to the target animal (see **ATTRACTANTS** below). Some individual target animals including coyotes and red foxes avoid cage traps (Phillips and Schmidt 1994, Shivik et al. 2005). Shivik et al. (2005) noted that it is, "exceedingly difficult to capture coyotes in cage-traps in agricultural areas (where damage is occurring)" and that "cage-traps are not likely to be feasible tools". Similarly, authors have noted that although cage traps are sometimes effective at capturing red foxes (Baker et al. 2001, Phillips and Schmidt 1994) it is difficult to trap an adult red fox in a cage trap (Phillips and Schmidt 1994). Some non-target animals become "trap happy" and purposely get captured to eat the bait, making the trap unavailable to catch target animals. These behaviors can make a cage trap less effective. Cage traps must be checked frequently to ensure that captured animals are not subjected to extreme environmental conditions. For example, an animal may die quickly if the cage trap is placed in direct summertime sunlight. Another potential problem with the use of cage traps is that some animals fight to escape and injure themselves in the process. WS SOPs require that traps be checked frequently so any captured animals can be addressed in a timely manner. Careful placement of traps at locations likely to capture target animals and the use of appropriate attractants further increases the selectivity of this method. Non-target species are released during these checks unless it is determined that the animal would not survive or that the animal cannot be released safely.

Foot-hold traps: Foot-hold traps are spring powered devices set in the ground which grasp and restrain an animal by its foot when the triggering mechanism is stepped on and two curved bars close to hold it. Traps are specifically designed in different sizes for different sized animals and can be equipped with tension setting devices which exclude non-target animals weighing less than the target animal. Animals that weigh more than the target animal are typically excluded because they can easily overcome the holding power generated by the springs and free themselves. Careful placement of traps at locations likely to capture target animals and the use of appropriate attractants (see **ATTRACTANTS** below)

further increases the selectivity of this method. WS SOPs require that traps are checked frequently so any captured animals can be addressed in a timely manner. Non-target species are released during these checks unless it is determined that the animal would not survive or that the animal cannot be released safely. Following Best Management Practices, which are carefully researched recommendations, ensures that standards for animal welfare, efficiency, selectivity, practicality and safety are met (AFWA 2014*a*; 2014*b*). Best Management Practice research conducted by the Association of Fish and Wildlife Agencies is ongoing which ensures improvement and modernization as new tools become available. Additionally WS has worked for many years on modifications to increase the selectivity, effectiveness and humaneness of foot-hold traps (Fagerstone and Keirn 2012). Foot-hold traps are difficult to keep operational during wet or freezing conditions and may require more time and labor than other methods.

Snares (Cable Device): Cable restraints also known as snares may be used as either live capture or lethal devices. Modern snares are composed of stranded steel cable formed into a loop with a sliding lock and affixed to an immovable object or a stake. As the snare loop is pulled closed by the forward movement of the animal being captured, the lock slides down the cable, but the lock cannot slide in the opposite direction. Snares set to capture an animal by the neck are usually lethal, while snares positioned to capture the animal around the body or leg can be used as a live capture method. The use of "stops" which keep the cable from becoming completely restricted allows for their use as a live capture method. Careful placement of snares at locations where target animals are moving through a restricted area (e.g. a hole in a fence into a pasture, trail through thick vegetation adjacent to a pasture) and the use of appropriate attractants (see **ATTRACTANTS** below) increases the selectivity of this method. The incorporation of 'break away' devices also increases selectivity, enabling larger non-target animals to prevent the snare from restraining them. WS SOPs require that snares are checked frequently so any captured animals can be addressed in a timely manner. Non-target species are released during these checks unless it is determined that the animal would not survive or that the animal cannot be released safely. Dogs captured in snares and accompanied by humans can be released unharmed. Following Best Management Practices, which are carefully researched recommendations, ensures that standards for animal welfare, efficiency, selectivity, practicality and safety are met (AFWA 2014*a*; 2014*b*). Best Management Practice research conducted by the Association of Fish and Wildlife Agencies is ongoing which ensures improvement and modernization as new tools become available.

Attractants: Attractants including, baits, scents or lures are used to increase the efficacy of other methods by enticing an animal to investigate a particular location where capture methods (e.g. cage traps, foot-hold traps) or toxicants (e.g. M-44 devices) are deployed. These attractants can be either natural or synthetically based. Scents or lures are usually blends of volatile natural substances including urine, musk, organs (glands) and essential oils (Turkowski et al. 1983, Kimball et al. 2000). However, attractants can also be synthetically based. For example, fatty acid scent is a synthetic mixture of several volatile fatty acids found in fermented egg (Roughton 1982, MSDS 2005). Baits include any foods or combination of foods attractive to the target animal. Visual attractants (e.g., feathers) can also be used to entice an animal to investigate a particular location. No known attractants are registered for use with coyote, dog or red fox. Attractants are non-restricted substances available for use by the public.

DOGS

Trained dogs may be used to assist in locating appropriate locations to place capture devices by alerting their handlers to areas where predators have traveled, urinated, or defecated. This use of trained dogs may increase the selectivity of both live and lethal capture methods. When conditions allow trained dogs can also aid in the application of other methods (e.g. shooting) by detecting coyotes, dogs or red foxes or their dens or alternatively to attract (decoy) animals into shooting range. These dogs may also scent mark (urinate or defecate) which may serve as an attractant. Dogs trained and used for this purpose must stay with their handler to be effective. Properly trained and disciplined dogs should not make contact with

target animals and have minimal effect on non-target animals. WS would use trained dogs in compliance with WS Directive 2.445.

NON-LETHAL METHODS (CHEMICAL)

Non-lethal chemical methods could include reproductive inhibitors and repellents.

Reproductive Inhibitors: Reproductive control for wildlife can be accomplished either through sterilization (permanent) or contraception (reversible) means. However, the use and effectiveness of reproductive control as a wildlife population management tool is limited by characteristics of the species (e.g., life expectancy, age at onset of reproduction, population size, etc.), environmental factors (e.g., isolation of target population, access to target individuals, etc.), socioeconomic, and other factors. Although research is ongoing, no known reproductive inhibitor has been registered by the EPA for use in coyotes, feral dogs or red foxes (Fagerstone et al. 2010, Massei and Miller 2013).

Repellents: Repellents that cause sickness are effective when sickness (e.g. nausea) follows consumption of a particular food item and an animal develops an aversion to that food item (Conover 2002). Although these types of repellents have not been tested with coyotes, dogs or red foxes, their utility seems limited because although repellents have shown some ability to reduce consumption of prey they have not shown the ability to reduce the killing of prey (Mason et al. 2001). No known chemical repellants are registered for use with coyote, dog or red fox.

LETHAL METHODS (NON-CHEMICAL)

Recreational Hunting and Trapping: Where appropriate, WS recommends that livestock producers consider hunting or trapping at the damage site as an option for reducing damage. Coyotes are classified as a nuisance species in Virginia and can be hunted or trapped and euthanized at any time (§ 29.1-511, § 29.1-520, § 29.1-530). Red fox may be hunted or trapped and euthanized during established seasons with the exception of a few counties. Hunting and trapping not only has the potential to remove individuals causing damage but also reinforces harassment programs as part of an integrated approach. Valid hunting and trapping licenses are required for the implementation of this method unless exempt.

Shooting: Shooting is the practice of selectively removing target animals using firearms. Shooting, when deemed appropriate, can be highly effective in removing those individual animals responsible for causing damage and posing threats. It is selective for target species. It is also effective in supplementing harassment as part of an integrated approach. Shooting may be used to lethally remove coyotes at any time, to lethally remove dogs or hybrid canines when they are "in the act of killing or injuring livestock" or "chasing livestock on land utilized by the livestock when the circumstances show that such chasing is harmful to the livestock" (§ 3.2-6552, § 3.2-6583) and to lethally remove foxes when they are causing damage or a nuisance or at any time by a landowner or their designee. Animals removed by WS are killed as quickly and humanely as possible in accordance with WS Directive 2.505.

Calling: Calling refers to the use of mouth or electronically recorded and mechanically amplified animal calls or sounds to attract animals into shooting range.

Decoy dogs: Trained dogs can aid in the application of shooting by attracting (decoying) animals into shooting range. Dogs trained and used for this purpose must stay with their handler to be effective. Properly trained and disciplined dogs should not make contact with target animals and have minimal effect on non-target animals. WS would use trained dogs in compliance with WS Directive 2.445.
Live Capture Followed by Euthanasia: Animals can be live captured through the use of several methods listed and described in detail above (see **CAPTURE WITH LIVE CAPTURE DEVICES**).

Upon capture, euthanasia could occur via shooting. WS would kill animals as quickly and humanely as possible in accordance with WS Directive 2.505.

Snares (Cable Device): Cable restraints also known as snares may be used as either live capture or lethal devices. Modern snares are composed of stranded steel cable formed into a loop with a sliding lock and affixed to an immovable object or a stake. As the snare loop is pulled closed (by the forward movement of the animal being captured), the lock slides down the cable but the lock cannot slide in the opposite direction. Snares set to capture an animal by the neck are usually lethal. Careful placement of snares at locations where target animals are moving through a restricted area (e.g. a hole in a fence into a pasture, trail through thick vegetation adjacent to a pasture) and the use of appropriate attractants (see **ATTRACTANTS** above) increases the selectivity of this method. The incorporation of 'stops' and 'break away' devices also increases selectivity, enabling some non-target animals to avoid restraint. WS would incorporate these devices in compliance with WS Directive 2.450b. WS SOPs require that snares are checked frequently so any captured animals can be addressed in a timely manner. Non-target species are released during these checks unless it is determined that the animal would not survive or that the animal cannot be released safely. Dogs captured in snares and accompanied by humans can be released unharmed. Following Best Management Practices, which are carefully researched recommendations, ensures that standards for animal welfare, efficiency, selectivity, practicality and safety are met (AFWA 2014a; 2014b). Best Management Practice research conducted by the Association of Fish and Wildlife Agencies is ongoing which ensures improvement and modernization as new tools become available.

Denning: The practice of locating and lethally removing animals at the location of a den is known as denning. Den sites are used by coyotes and red fox for bearing and rearing young (Parker 1995, Cypher 2003). Coyotes and red foxes are territorial and each territory is typically controlled and maintained by a dominant breeding pair (Lloyd 1983; Gese and Ruff 1997; 1998). The breeding pair produces a single litter each spring (Cypher 2003, Bekoff and Gese 2003). Studies have demonstrated that the need to feed pups is an important factor for motivating coyotes to kill livestock (Till and Knowlton 1983, Bromley and Gese 2001) and that breeding coyotes are responsible for most sheep depredations (Till and Knowlton 1983, Sacks et al. 1999*a*). The removal of pups or pups and adults can result in substantial decreases in livestock predation (Till and Knowlton 1983). Similarly, coyotes with pups are more likely to kill livestock than coyotes without pups (Bromley and Gese 2001). Denning is highly selective for target species and individuals. However, dens can be exceedingly difficult to locate rendering the method labor intensive. Denning methods may include euthanasia with large gas cartridges (see **large gas cartridges)** or via live capture and euthanasia. WS would kill animals as quickly and humanely as possible in accordance with WS Directive 2.505.

LETHAL METHODS (CHEMICAL)

The use of chemical methods is strictly regulated by the EPA and VDACS. All pesticides have to be registered with the Environmental Protection Agency (EPA) and must have labels approved by the agency which detail the product's ingredients, the type of pesticide, the formulation, classification, approved uses and formulations, potential hazards to humans, animals and the environment and directions for use. The registration process for pesticides is intended to assure minimal adverse effects to humans, animals and the environment when chemicals are used in accordance with label directions. Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and its implementing guidelines, it is a violation of federal law to use any pesticide in a manner that is inconsistent with its label. These chemicals can only be applied by persons who have been specially trained and certified by the VDACS for their use. These persons (certified applicators) are required to take continuing education classes and exams to maintain their certification. Each of the chemical methods listed below have specific requirements for their handling, transport, storage, application and disposal under the Code of Virginia and the Virginia Administrative Code.

All chemicals used by WS are registered as required by the FIFRA (administered by the EPA and the VDACS). WS' personnel that use restricted-use chemical methods are certified as pesticide applicators by the Commonwealth of Virginia and are required to adhere to all certification requirements set forth in FIFRA and Virginia pesticide control laws and regulations. Additionally, WS' personnel that use restricted-use chemical methods would abide by all Federal and State laws and regulations for their handling, transport, storage, application and disposal. Chemicals are only used on private, public, or tribal property sites with authorization from the property owner or manager.

M-44s (sodium cyanide) *(EPA Reg. No. 56228-15)***:** Sodium cyanide is a restricted use pesticide administered in a single dose by the M-44 device (EPA 2006b). An M-44 device is triggered when an animal bites and pulls on the top of the device which is staked into the ground and covered in a fetid attractant or lure. When the device is triggered, sodium cyanide powder is ejected into the mouth and reacts with moisture to produce hydrogen cyanide gas (USDA 2010). The gas is absorbed into the lungs and death by chemical asphyxiation occurs because cyanide inhibits an enzyme essential to the utilization of oxygen (EPA 1994). Sodium cyanide is supplied by the manufacture to the applicator in sealed single dose capsules which are inserted directly into the M-44 device. M-44s are registered for use in managing coyote, dog and red fox which are suspected of preying upon livestock and poultry. M-44s are registered for use in Virginia by WS only and therefore would only be available under the proposed action alternative.

WS would only place M-44s on a given property in response for a request for assistance after the property owner or manager has signed a document agreeing to allow M-44s be used on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the property of control activities. M-44s would be used by WS in accordance with the EPA's 26 use restrictions to minimize risks to humans, non-target animals and the environment (WS Directive 2.415). Additionally, WS use of M-44s would be restricted to fenced areas where livestock graze in accordance with WS Directive 2.415(c). For detailed discussions on the potential effects of the use of M-44s on dogs, non-target animals, human health and safety and the environment see **CHAPTER 4**.

M-44s (sodium cyanide) Primary Hazard Profile - Sodium cyanide is a restricted use pesticide administered in a single dose in the M-44 device (EPA 2006b). The likelihood of obtaining a lethal dose is dependent on encountering an M-44 device in an area where livestock graze and triggering a device by pulling on the top of the device which is staked into the ground. Shivik et al. (2014) found that only one other species, cows, were equally or more likely than coyotes to investigate M-44's set to protect livestock in pastures in Virginia and West Virginia but that no non-canid activated an M-44. Non-canids such as cows are generally not susceptible to M-44's because they do not grab and pull on M-44 devices (Shivik et al. 2014). Animals triggering the device die in approximately two minutes (Connolly et al. 1986) and appear to show no overt signs of distress or pain (USDA 2010). Acute lethal dose (LD50)[6] values have been estimated for a variety of bird, mammal and aquatic species (Wiemeyer et al. 1986, Timm 1994, HSDB 2015). Acute lethal doses (LD_{50}) values for canids range from 4 to 8 mg/kg (Chen and Rose 1952, Savarie and Garrison 1976, Sterner 1979). When ingested at sub toxic levels it is rapidly detoxified and excreted by the kidneys (EPA 2006a). Mortality or any adverse effect on growth or reproduction is unlikely to result from sub lethal or repeated sub-lethal exposures (Howard and Hanzal 1955).

[6] An LD50 is the dosage in milligrams of material per kilogram of body weight required to cause death in 50% of a test population of a species.

*M-44s (sodium cyanide) Secondary Hazards-*Secondary poisoning is unlikely to nonexistent because the chemical reaction and mode of action (chemical asphyxiation) limits the amount of compound present in tissues that could be available to scavengers (Howard and Hanzal 1955). Additionally, as stated above when ingested at sub toxic levels it is rapidly detoxified and excreted by the kidneys (EPA 2006a, HSDB 2015).

M-44s (sodium cyanide) Environmental Degradation- When used together with the M-44 device sodium cyanide does not pose an environmental risk when used according to the label (EPA 1994). Sodium cyanide is supplied by the manufacturer to the applicator in sealed single dose capsules which are inserted directly into the M-44 device. Requirements for the storage, transport and application of theses capsules eliminates the likelihood that non-targets would encounter sodium cyanide in the environment. Should a sodium cyanide capsule leak or be damaged, contact with moisture would cause the formation of hydrogen cyanide which would diffuse into the air and degrade into carbon dioxide and ammonia (Schafer 1990, EPA 1994). Sodium cyanide is soluble in water but use restrictions prohibit, "application within 200 feet of any lake, stream, or other body of water" (WS Directive 2.415). In soil, sodium cyanide is degraded by microorganisms into carbon dioxide and ammonia (USFWS 1975, EPA 1994). Thus, a potential impact to non-target livestock and wildlife populations including threatened and endangered species from environmental exposure is minimal to non-existent.

Livestock protection collars (sodium fluoroacetate) *(EPA Reg. No. 56228-22)***:** Sodium fluoroacetate, also known as compound 1080 is a restricted use pesticide administered via the livestock protection collar (LPC). LPCs are supplied by the manufacturer with the proper dosage of sodium fluoroacetate contained within the rubber pouches. The LPC, designed to fit around the neck of a sheep or goat has rubber pouches which contain a diluted sodium fluoroacetate solution. The solution is released from these rubber pouches into the mouth of a predator when they are punctured by the predator biting the neck of a sheep or goat wearing an LPC. Sodium fluoroacetate is rapidly absorbed by the gastrointestinal tract and metabolized to fluoroacetate which inhibits an enzyme essential for energy production leading to death from cardiac failure or respiratory arrest (EPA 1995). Sodium fluoroacetate is not readily absorbed through skin (Atzert 1971). A yellow dye added to sodium fluoroacetate solutions used in LPCs serves as an indicator that a rubber pouch has been punctured. LPCs are registered for use on sheep or goats to lethally remove coyotes. LPCs are registered for use by WS only and therefore would only be available under the proposed action alternative.

WS would only place LPCs on a given property in response for a request for assistance after the property owner or manager has signed a document agreeing to allow LPCs be used on property they own and/or manage. This document may advise these persons to contact and inform persons utilizing or adjoining the property of control activities. Additionally, WS verbally advises those persons to contact and inform persons utilizing or adjoining the property of control activities. LPCs would be used by WS in accordance with the technical bulletin to minimize risks to humans, non-target animals and the environment (WS Directive 2.420). For detailed discussions on the potential effects of the use of LPCs on dogs, non-target animals, human health and safety and the environment see **CHAPTER 4**.

Livestock protection collar (LPCs) (sodium fluoroacetate) Primary Hazard Profile - The likelihood of obtaining a lethal dose is primarily dependent upon encountering a flock of sheep or goats wearing LPCs in a fenced pasture and puncturing a rubber pouch by biting the neck of a sheep or goat with an LPC. Sodium fluoroacetate is rapidly absorbed by the gastrointestinal tract and metabolized to fluoroacetate which inhibits an enzyme essential for energy production leading to death from cardiac failure or respiratory arrest (EPA 1995). The principal risk of primary exposure to non-target animals is to scavengers which may feed on the head and neck area of coyote-killed livestock (EPA 1995). Sodium fluoroacetate is not readily absorbed through skin (Atzert 1971). Sodium fluoroacetate is more toxic to canines than most other non-target species (Atzert 1971, Connolly and Burns 1990). Acute lethal doses

(LD50)[1] values for canids range from 0.1 to 1.0 mg per kg (Ward and Spencer 1947, Connolly 1980, Hone and Mulligan 1982). In a laboratory study, three dogs were allowed to feed on coyote-killed collared goats. All three dogs fed until satiated and one dog was allowed to feed once or twice a day for nine days. No dogs showed adverse effects despite their high susceptibility to sodium fluoroacetate because the dogs did not chew on or feed near ruptured collars (Connolly 1980). In another laboratory study, five dogs were fed sheep contaminated with twice the amount of sodium fluoroacetate contained in a single LPC (Burns et al. 1984a, Burns and Connolly 1995). Three dogs showed no adverse effects while the other two dogs died after consuming fluoroacetate contaminated material (e.g., wool). The authors concluded that although there was a danger to dogs that eat contaminated wool or other material there is little risk to dogs that eat only the flesh of dead livestock which has low amounts of residue. Coyotes, hawks, ravens, skunks, vultures, and other species were observed feeding on coyote-killed collared animals but none were known to be effected (Littauer 1983, EPA 1995). Generally, scavengers avoided feeding near ruptured collars (Connolly 1980, EPA 1995). Livestock could be affected if they were to consume contaminated forage from a punctured collar. However, this type of poising has not been observed in field tests or applications (Burns et al. 1984a). Given the requirements for the disposal of animals, vegetation, soil or other material contaminated with sodium fluoroacetate the risk of primary toxicity from these sources from the use of LPCs is very low.

Livestock protection collar (LPCs) (sodium fluoroacetate) Secondary Hazards- Secondary toxicity to non-target animals could theoretically occur from animals scavenging on the carcass of a coyote receiving a lethal dose from an LPC or consuming the vomit of an effected coyote (EPA 1995). However, secondary poisoning to a non-target scavenger is unlikely because the levels of sodium fluoroacetate that persist in the tissues of coyotes receiving a lethal dose are relatively low (Connolly 1980, Littauer 1983). The highest concentration of sodium fluoroacetate in coyotes puncturing LPCs occurs in the stomach contents (Burns et al. 1984a, EPA 1995). However, the low amount of vomit that could be available or located along with the rapid degradation of vomit in the environment reduces the likelihood that non-target animals would be effected (EPA 1995).

Livestock protection collar (LPCs) (sodium fluoroacetate) Environmental Degradation- LPCs are supplied by the manufacturer with the proper dosage of sodium fluoroacetate contained within the rubber pouches. Requirements for the storage transport, application and disposal of LPCs eliminate the likelihood that non-target animals would encounter sodium fluoroacetate in the environment. Should an LPC be punctured or leak there are specific requirements for removing and disposing of contaminated vegetation, soil or other materials (EPA 1995). The EPA has concluded that when used according to its label, sodium fluoroacetate used in conjunction with the LPC does not pose unreasonable risks to the environment (EPA 1995). Thus, any potential impact to non-target animals from environmental exposure is likely to be minimal to non-existent.

Large Gas Cartridges *(EPA Reg. No. 56228-21)***:** Gas cartridges are composed of sodium nitrate and charcoal, both naturally occurring substances (EPA 1991). When ignited, gas cartridges produce carbon monoxide, a poisonous gas. Application involves igniting the cartridge, inserting it into an active coyote or red fox den and then plugging the den's entrance. In unventilated spaces, exposure to carbon monoxide causes a depletion of oxygen in the blood and death from respiratory failure. Carbon monoxide is recognized by the AVMA as an acceptable method of euthanasia (AVMA 2000). Large gas cartridges are registered for use in dens being actively used by coyotes and red foxes. Gas cartridges are non-restricted use pesticides and therefore would be available under any of the alternatives.

A common concern regarding the use of chemicals is the risk to humans, non-target animals and the environment. Gas cartridges would be used by WS in accordance with the label directions and SOPs which reduces risks to human health and safety. These requirements include but are not limited to; training in the application of the method, the use of appropriate personal protective equipment, the use of

caution during application to avoid burns to the skin or ignition of clothing or other materials; proper storage and disposal. Human exposure would be limited to applicators (EPA 1991). Risk to applicators would be negligible when used in accordance with the label (EPA 1991). Following label requirements eliminates the risk to non-target animals. Dens must be checked for non-target animals prior to application. Application is not permitted if non-target species are present. Finally, when used as a fumigant carbon monoxide would eventually diffuse through den openings or into the soil (EPA 1991). Sodium nitrate, charcoal, and carbon monoxide are naturally occurring substances and the nature of the application makes the likelihood of any negative impacts to the environment negligible to nonexistent. Euthanasia conducted by WS would be done in accordance with WS Directive 2.505.

APPENDIX C: SPECIES LISTED BY THE U.S. FISH AND WILDLIFE SERVICE[1]

[1]List obtained from U.S. Fish and Wildlife Service, Virginia Field Office, Ecological Services on 30 July 2015

Notes:

- As of 2/13/2015 the data in this report has been updated to use a different set of information. Results are based on where the species is believed to or known to occur. The FWS feels utilizing this data set is a better representation of species occurrence. Note: there may be other federally listed species that are not currently known or expected to occur in this state but are covered by the ESA wherever they are found; thus if new surveys detected them in this state they are still covered by the ESA. The FWS is using the best information available on this date to generate this list.
- This report shows the listed species or populations believed to or known to occur in Virginia.
- This list does not include experimental populations and similarity of appearance listings.
- This list includes species or populations under the sole jurisdiction of the National Marine Fisheries Service.

Summary of Animals listings:

Animals (58 species):

Status	Species
E	Bat, gray Entire (*Myotis grisescens*)
E	Bat, Indiana Entire (*Myotis sodalis*)
E	Bat, Northern long-eared (*Corynorhinus (=Plecotus) townsendii virginianus*)
E	Bat, Virginia big-eared Entire (*Corynorhinus (=Plecotus) townsendii virginianus*)
E	Bean, Cumberland (pearlymussel) Entire Range; Except where listed as Experimental Populations (*Villosa trabalis*)
E	Bean, purple (*Villosa perpurpurea*)
E	Bean, rayed (*Villosa fabalis*)
E	Blossom, green (pearlymussel) Entire (*Epioblasma torulosa gubernaculum*)
E	Butterfly, Mitchell's satyr Entire (*Neonympha mitchellii mitchellii*)
T	Chub, slender Entire (*Erimystax cahni*)
T	Chub, spotfin Entire (*Erimonax monachus*)
E	Combshell, Cumberlandian Entire Range; Except where listed as Experimental Populations (*Epioblasma brevidens*)
T	Dace, blackside Entire (*Phoxinus cumberlandensis*)
E	Darter, duskytail Entire (*Etheostoma percnurum*)
E	Fanshell (*Cyprogenia stegaria*)
E	Isopod, Lee County cave Entire (*Lirceus usdagalun*)
T	Isopod, Madison Cave Entire (*Antrolana lira*)
E	Kidneyshell, fluted (*Ptychobranchus subtentum*)
T	Knot, red (*Calidris canutus rufa*)
E	Logperch, Roanoke Entire (*Percina rex*)
T	Madtom, yellowfin Entire, except where EXPN (*Noturus flavipinnis*)
E	Monkeyface, Appalachian (pearlymussel) (*Quadrula sparsa*)
E	Monkeyface, Cumberland (pearlymussel) Entire Range; Except where listed as Experimental Populations (*Quadrula intermedia*)
E	Mucket, pink (pearlymussel) Entire (*Lampsilis abrupta*)
E	Mussel, oyster Entire Range; Except where listed as Experimental Populations (*Epioblasma capsaeformis*)
E	Mussel, sheepnose (*Plethobasus cyphyus*)
E	Mussel, snuffbox (*Epioblasma triquetra*)
E	Pearlymussel, birdwing Entire Range; Except where listed as Experimental Populations (*Lemiox*

	rimosus)
E	Pearlymussel, cracking Entire Range; Except where listed as Experimental Populations (*Hemistena lata*)
E	Pearlymussel, dromedary Entire Range; Except where listed as Experimental Populations (*Dromus dromas*)
E	Pearlymussel, littlewing Entire (*Pegias fabula*)
E	Pearlymussel, slabside (*Pleuronaia dolabelloides*)
E	Pigtoe, finerayed Entire Range; Except where listed as Experimental Populations (*Fusconaia cuneolus*)
E	Pigtoe, rough (*Pleurobema plenum*)
E	Pigtoe, shiny Entire Range; Except where listed as Experimental Populations (*Fusconaia cor*)
T	Plover, piping except Great Lakes watershed (*Charadrius melodus*)
E	Rabbitsfoot, rough (*Quadrula cylindrica strigillata*)
E	Riffleshell, tan Entire (*Epioblasma florentina walkeri* (*=E. walkeri*))
E	Salamander, Shenandoah Entire (*Plethodon shenandoah*)
T	Sea turtle, green Except where endangered (*Chelonia mydas*)
E	Sea turtle, hawksbill Entire (*Eretmochelys imbricata*)
E	Sea turtle, Kemp's ridley Entire (*Lepidochelys kempii*)
E	Sea turtle, leatherback Entire (*Dermochelys coriacea*)
T	Sea turtle, loggerhead Northwest Atlantic Ocean DPS (*Caretta caretta*)
E	Snail, Virginia fringed mountain Entire (*Polygyriscus virginianus*)
E	Spectaclecase (mussel) (*Cumberlandia monodonta*)
E	Spider, spruce-fir moss (*Microhexura montivaga*)
E	Spinymussel, James Entire (*Pleurobema collina*)
E	Squirrel, Carolina northern flying Entire (*Glaucomys sabrinus coloratus*)
E	Squirrel, Delmarva Peninsula fox Entire, except Sussex Co., DE (*Sciurus niger cinereus*)
E	Sturgeon, shortnose Entire (*Acipenser brevirostrum*)
E	Tern, roseate northeast U.S. nesting pop. (*Sterna dougallii dougallii*)
T	Tiger beetle, Northeastern beach Entire (*Cicindela dorsalis dorsalis*)
E	Wedgemussel, dwarf Entire (*Alasmidonta heterodon*)
E	Whale, finback Entire (*Balaenoptera physalus*)
E	Whale, humpback Entire (*Megaptera novaeangliae*)
E	Whale, North Atlantic Right Entire (*Eubalaena glacialis*)
E	Woodpecker, red-cockaded Entire (*Picoides borealis*)

Plants (18 species):

Status	**Species**
T	Amaranth, seabeach (*Amaranthus pumilus*)
T	Birch, Virginia round-leaf (*Betula uber*)
E	Bittercress, small-anthered (*Cardamine micranthera*)
E	Bluet, Roan Mountain (*Hedyotis purpurea var. montana*)
E	Bulrush, Northeastern (*Scirpus ancistrochaetus*)
E	Chaffseed, American (*Schwalbea americana*)
E	Coneflower, smooth (*Echinacea laevigata*)
E	Harperella (*Ptilimnium nodosum*)

T	Joint-vetch, Sensitive (*Aeschynomene virginica*)
E	Lichen, rock gnome (*Gymnoderma lineare*)
E	Mallow, Peter's Mountain (*Iliamna corei*)
T	Orchid, eastern prairie fringed (*Platanthera leucophaea*)
T	Pink, swamp (*Helonias bullata*)
T	Pogonia, small whorled (*Isotria medeoloides*)
E	rock cress, Shale barren (*Arabis serotina*)
T	Sneezeweed, Virginia (*Helenium virginicum*)
T	Spiraea, Virginia (*Spiraea virginiana*)
E	Sumac, Michaux's (*Rhus michauxii*)

APPENDIX D: SPECIES LISTED BY THE COMMONWEALTH OF VIRGINIA[1]

[1]List obtained from < http://www.dgif.virginia.gov/wildlife/virginiatescspecies.pdf > and <https://vanhde.org/species-search> on 2 April 2015

Common Name	***Scientific Name***	**Status**
Amphibians		
Mabee's Salamander	*Ambystoma mabeei*	LT
Tiger Salamander	*Ambystoma tigrinum*	LE
Barking Treefrog	*Hyla gratiosa*	LT
Shenandoah Salamander	*Plethodon shenandoah*	LE
Arachnida (spiders and pseudoscorpions)		
Spruce-fir moss spider	*Microhexura montivaga*	LE
Birds		
Henslow's Sparrow	*Ammodramus henslowii*	LT
Upland Sandpiper	*Bartramia longicauda*	LT
Piping Plover	*Charadrius melodus*	LT
Wilson's Plover	*Charadrius wilsonia*	LE
Peregrine Falcon	*Falco peregrinus*	LT
Gull-billed Tern	*Gelochelidon nilotica*	LT
Roseate tern	*Sterna dougallii dougallii*	LE
Loggerhead Shrike	*Lanius ludovicianus*	LT
Black Rail	*Laterallus jamaicensis*	LE
Bachman's Sparrow	*Peucaea aestivalis*	LT
Red-cockaded Woodpecker	*Picoides borealis*	LE
Appalachian Bewick's Wren	*Thryomanes bewickii altus*	LE
Bachman's warbler (=wood)	*Vermivora bachmanii*	LE
Kirtland's warbler (=wood)	*Dendroica kirtlandii*	LE
Bivalvia (mussels)		
Dwarf Wedgemussel	*Alasmidonta heterodon*	LE
Brook Floater	*Alasmidonta varicosa*	LE
Slippershell Mussel	*Alasmidonta viridis*	LE
Spectaclecase	*Cumberlandia monodonta*	LE
Fanshell	*Cyprogenia stegaria*	LE
Dromedary Pearlymussel	*Dromus dromas*	LE
Elephant Ear	*Elliptio crassidens*	LE
Cumberland Combshell	*Epioblasma brevidens*	LE
Oyster Mussel	*Epioblasma capsaeformis*	LE
Tan Riffleshell	*Epioblasma florentina aureola*	LE
Green-blossom Pearlymussel	*Epioblasma torulosa gubernaculum*	LE
Snuffbox	*Epioblasma triquetra*	LE
Shiny Pigtoe	*Fusconaia cor*	LE
Fine-rayed Pigtoe	*Fusconaia cuneolus*	LE
Atlantic Pigtoe	*Fusconaia masoni*	LT
Cracking Pearlymussel	*Hemistena lata*	LE
Pink Mucket	*Lampsilis abrupta*	LE
Tennessee Heelsplitter	*Lasmigona holstonia*	LE

Green Floater	*Lasmigona subviridis*	LT
Birdwing Pearlymussel	*Lemiox rimosus*	LE
Fragile Papershell	*Leptodea fragilis*	LT
Black Sandshell	*Ligumia recta*	LT
Little-winged Pearlymussel	*Pegias fabula*	LE
Sheepnose	*Plethobasus cyphyus*	LE
James Spinymussel	*Pleurobema collina*	LE
Ohio Pigtoe	*Pleurobema cordatum*	LE
Rough Pigtoe	*Pleurobema plenum*	LE
Pyramid Pigtoe	*Pleurobema rubrum*	LE
Slabside Pearlymussel	*Pleuronaia dolabelloides*	LE
Rough Rabbits Foot	*Quadrula cylindrica strigillata*	LE
Cumberland Monkeyface	*Quadrula intermedia*	LE
Pimple Back	*Quadrula pustulosa*	LT
Appalachian Monkeyface	*Quadrula sparsa*	LE
Purple Liliput	*Toxolasma lividum*	LE
Deertoe	*Truncilla truncata*	LE
Purple Bean	*Villosa perpurpurea*	LE
Cumberland Bean	*Villosa trabalis*	LE
Pistolgrip	*Tritogonia verrucosa*	LT
Rayed Bean	*Villosa fabalis*	LE
Coleoptera (beetles)		
Northeastern Beach Tiger Beetle	*Cicindela dorsalis dorsalis*	LT
Holsinger's Cave Beetle	*Pseudanophthalmus holsingeri*	LE
Crustacea (Amphipods, Isopods, and decapods)		
Madison Cave Isopod	*Antrolana Iira*	LT
Big Sandy Crayfish	*Cambarus veteranus*	LE
Lee County Cave Isopod	*Lirceus usdagalun*	LE
Madison Cave Amphipod	*Stygobromus stegerorum*	LT
Diplopoda (millipedes)		
Ellett Valley Pseudotremia Millipede	*Pseudotremia cavernarum*	LT
Laurel Creek Xystodesmid Millipede	*Sigmoria whiteheadi*	LT
Fish		
Atlantic Sturgeon	*Acipenser oxyrinchus*	LE
Western Sand Darter	*Ammocrypta clara*	LT
Blackside Dace	*Chrosomus cumberlandensis*	LT
Tennessee Dace	*Chrosomus tennesseensis*	LE
Steelcolor Shiner	*Cyprinella whipplei*	LT
Blackbanded Sunfish	*Enneacanthus chaetodon*	LE
Turquoise Shiner (Spotfin chub)	*Erimonax monachus*	LT
Slender Chub	*Erimystax cahni*	LT
Sharphead Darter	*Etheostoma acuticeps*	LE
Greenfin Darter	*Etheostoma chlorobranchium*	LT
Carolina Darter	*Etheostoma collis*	LT

Golden Darter	*Etheostoma denoncourti*	LT
Duskytail Darter	*Etheostoma percnurum*	LE
Whitemouth Shiner	*Notropis alborus*	LT
Emerald Shiner	*Notropis atherinoides*	LT
Yellowfin Madtom	*Noturus flavipinnis*	LT
Orangefin Madtom	*Noturus gilberti*	LT
Roanoke Logperch	*Percina rex*	LE
Sickle darter	*Percina williamsi*	LT
Paddlefish	*Polyodon spathula*	LT
Shortnose sturgeon	*Acipenser brevirostrum*	LE
Variegate darter	*Etheostoma variatum*	LE
Gastropoda (snails)		
Appalachian Springsnail	*Fontigens bottimeri*	LE
Virginia Springsnail	*Fontigens morrisoni*	LE
Shaggy Coil	*Helicodiscus diadema*	LE
Rubble Coil	*Helicodiscus lirellus*	LE
Thankless ghostsnail	*Holsingeria unthanksensis*	LE
Spiny Riversnail	*Io fluvialis*	LT
Spirit Supercoil	*Paravitrea hera*	LE
Brown Supercoil	*Paravitrea septadens*	LT
Virginia Fringed Mountain Snail (=Virginia coil)	*Polygyriscus virginianus*	LE
Spider elimia	*Elimia arachnoidea*	LE
Heteroptera (true bugs)		
Virginia Piedmont Water Boatman	*Sigara depressa*	LE
Homoptera (cicadas and leaf hoppers)		
Buffalo Mountain mealybug	*Puto kosztarabi*	LE
Lepidoptera (butterflies and moths)		
Mitchell's satyr	*Neonympha mitchellii*	LE
Appalachian grizzled skipper	*Pyrgus centaureae wyandot*	LT
Mammals		
Eastern Big-eared Bat	*Corynorhinus rafinesquii macrotis*	LE
Virginia Big-eared Bat	*Corynorhinus townsendii virginianus*	LE
Carolina Northern Flying Squirrel	*Glaucomys sabrinus coloratus*	LE
Virginia Northern Flying Squirrel	*Glaucomys sabrinus fuscus*	LE
Snowshoe Hare	*Lepus americanus*	LE
Southern Rock Vole	*Microtus chrotorrhinus carolinensis*	LE
Gray Bat	*Myotis grisescens*	LE
Indiana Bat	*Myotis sodalis*	LE
Delmarva Fox Squirrel	*Sciurus niger cinereus*	LE
Dismal Swamp Southeastern Shrew	*Sorex longirostris fisheri*	LT
Southern Water Shrew	*Sorex palustris punctulatus*	LE
American Water Shrew	*Sorex palustris*	SE

Eastern puma	*Puma (Felis) concolor cougar*	LE
Gray wolf	*Canis lupus*	LE
Blue whale	*Balaenoptera musculus*	LE
Finback whale	*Balaenoptera physalus*	LE
Humpback whale	*Meagaptera novaeangliae*	LE
North Atlantic Right whale	*Eubalaena glacialis*	LE
Sei whale	*Balaenoptera borealis*	LE
Sperm whale	*Physeter catodon (=macrocephalus)*	LE
West Indian manatee	*Trichechus manatus*	LE
Reptiles		
Loggerhead (Sea Turtle)	*Caretta caretta*	LT
Canebrake Rattlesnake	*Crotalus horridus [Coastal Plain population]*	LE
Chicken Turtle	*Deirochelys reticularia*	LE
Wood Turtle	*Glyptemys insculpta*	LT
Bog Turtle	*Glyptemys muhlenbergii*	LE
Eastern Glass Lizard	*Ophisaurus ventralis*	LT
Green sea turtle	*Chelonia mydas*	LT
Hawksbill sea turtle	*Eretmochelys imbricata*	LE
Kemp's ridley sea turtle	*Lepidochelys kempii*	LE
Leatherback sea turtle	*Dermochelys coriacea*	LE
Vascular Plants		
Sensitive Joint-vetch	*Aeschynomene virginica*	LT
Sea-beach amaranth	*Amaranthus pumilus*	LT
Virginia Roundleaf birch	*Betula lenta var. uber*	LE
Shale barren rock cress	*Boechera serotina*	LT
Valley Doll’s – daisy	*Boltonia montana*	LE
Small-anthered Bittercress	*Cardamine micranthera*	LE
Juniper sedge	*Carex juniperorum*	LE
Millboro leatherflower	*Clematis viticanlis*	LT
Bentley's coralroot	*Corallorhiza bentleyi*	LE
Smooth Coneflower	*Echinacea laevigata*	LT
Harper's fimbry	*Fimbristylis perpusilla*	LE
Harperella	*Harperella nodosa*	LE
Virginia Sneezeweed	*Helenium virginicum*	LE
Swamp-pink	*Helonias bullata*	LE
Long-stalked Holly	*Ilex collina*	LE
Peters Mountain mallow	*Iliamna corei*	LE
Virginia quillwort	*Isoletes virginica*	LE
Small Whorled Pogonia	*Isotria medeoloides*	LE
New Jersey Rush	*Juncus caesariensis*	LT
Nestronia	*Nestronia umbellula*	LE
Narrow-leaved Spatterdock	*Nuphar sagittifolia*	LT
Prairie fringed orchid	*Platanthera leucophaea*	LT

Michaux's Sumac	*Rhus michauxii*	LT
Northeastern Bulrush	*Scirpus ancistrochaetus*	LE
Reclining Bulrush	*Scirpus flaccidifolius*	LT
Virginia Spiraea	*Spiraea virginiana*	LE
Running Glade Clover	*Trifolium calcaricum*	LE

[2] In the Commonwealth of Virginia, plants and insects fall under one authority while amphibians, wild birds, mussels, fish, gastropods, mammals and reptiles fall under the jurisdiction of another authority. Each authority, as outlined below, has different definitions for listing status.

Plant and Insect Status Codes and Definitions:
Code of Virginia, Title 3.2, Chapter 10, sections 1000–1011. This section of the Code gives the Virginia Department of Agriculture and Consumer Services legislative authority over the listing, protection and taking of threatened and endangered plant and insect species in the Commonwealth.

LE (Endangered): Any species or variety of plant life or insect life determined by the Board to be in danger of extinction throughout all or a significant part of its range other than a species determined by the Commissioner not to be in the best interest of the welfare of man.

LT (Threatened): Any species determined by the Board to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its native range.

Fish and Wildlife Status Codes and Definitions:
Code of Virginia, Title 29.1, Chapter 5, sections 563–568. This section of the Code gives the Virginia Department of Game and Inland Fisheries legislative authority over the listing, protection and taking of threatened and endangered fish and wildlife species in the Commonwealth.

LE (Endangered): Any species which is in danger of extinction throughout all or a significant portion of its range.

LT (Threatened): Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.