ENVIRONMENTAL ASSESSMENT

Managing Damage to Resources and Threats to Human Health and Safety Caused by Mammals in Delaware

Lead Agency:
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services

Cooperating Agency:
U.S. Department of Interior
U.S. Fish and Wildlife Service

Agencies Consulted:
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ACRONYMS

AFWA	Association of Fish and Wildlife Agencies
APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
CDC	U.S. Department of Health and Human Services, Centers for Disease Control
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CSA	Cooperative Service Agreement
CWA	Clean Water Act
DEA	U.S. Department of Justice, Drug Enforcement Administration
DNREC	Department of Natural Resources and Environmental Control
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
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NMFS	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NWRC	U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center
USACE	U.S. Department of Defense, Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Department of the Interior, U.S. Fish and Wildlife Service
SOP	Standard Operating Procedures
WS-Delaware	U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services Program in Delaware

CHAPTER 1: NEED FOR ACTION AND SCOPE OF ANALYSIS

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 mammal damage management in Delaware. 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)[1] in which a combination of methods may be used or recommended to reduce damage. Program activities 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 direct, indirect, 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[2] to document the analyses associated with proposed federal actions and to inform decision-makers and the

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[1] WS Program Directives are available at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_WS_Program_Directives

[2] 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).

public of reasonable alternatives capable of avoiding or minimizing significant effects. This EA will also 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 NEED FOR ACTION

WS continues to receive requests for assistance to resolve or prevent damage occurring to agricultural resources, natural resources, property, and reduce or prevent threats to human health and safety associated with mammal species, including Virginia opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), woodchuck (*Marmota monax*), gray squirrel (*Sciurus carolinensus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor),* striped skunk *(Mephitis mephitis),* river otter *(Lutra Canadensis),* white-tailed deer (*Odocoileus virginianus*) and feral swine (*Sus scrofa*). This EA will assist in determining if the proposed management of mammal 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 Delaware as part of a coordinated program.

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 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.

Mammals 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 experiencing damage, consider the mammals 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 associated with mammals in Delaware arises from requests for assistance[3] received by WS to reduce and prevent damage. While WS has received only a few requests for service for certain species, the agency is expecting greater demand for service due to rapidly expanding wildlife populations and higher incidence of conflicts with people.

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 2 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 2 of this EA. The numbers of requests for assistance are representative of the damage and threats that could be caused by mammals. Many of the requests for assistance involved multiple resources and multiple species.

[3] 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.

Table 1.1 lists mammal species addressed in this EA and the resource types that these species can cause damage to in Delaware. Many of the mammal species addressed in this EA can cause damage to or pose threats to more than one resource. Chapter 3 lists specific small mammal species that WS could be requested to address infrequently. Those species would primarily be associated with threats of aircraft strikes at airports or damage to agriculture. Specific information regarding mammal damage to agricultural resources, natural resources, property, and reduce or prevent threats to human health and safety are discussed in the following subsections.

Table 1.1 – Primary mammal species addressed in the EA and resources affected by these mammal species[1].

Species	Resource			
	Agriculture	Natural Resources	Property	Human Safety
Virginia Opossum	X	X	X	X
Eastern cottontail	X		X	X
Woodchuck	X		X	X
Eastern Gray Squirrel	X		X	
Beaver	X	X	X	X
Muskrat	X	X	X	
Coyote	X	X	X	X
Red Fox	X	X	X	X
Gray Fox	X	X	X	X
Raccoon	X	X	X	X
Striped Skunk	X	X	X	X
River Otter	X	X		
White-tailed Deer	X	X	X	X
Feral Swine	X	X	X	X

Need for Mammal Damage Management to Reduce or Prevent Threats to Human Health and Safety

Requests received by WS for assistance in reducing or preventing threats to human health and safety from mammals fall into four categories.

Threat of disease transmission

Zoonotic diseases are animal diseases which are transmissible to people. Pathogen transmission can occur through direct interactions between humans and mammals as well as indirect interactions with pets and livestock that had contact with mammals. Pets and livestock often encounter and interact with wild mammals, which can increase the possibility of transmission to people. With the exception of arthropod-

borne (e.g., ticks) pathogens, transmission from wild and free ranging mammals to humans is uncommon. However, the infrequency of such transmissions does not diminish the concerns of those individuals requesting assistance because pathogen transmissions are documented and possible. Diseases which can be transmitted from wild or free ranging mammals to humans may be bacterial, spirochetal, rickettsial, viral, fungal, prions or parasites.

WS continues to receive requests for assistance from persons concerned about the potential risk of transmission of diseases to humans from wild and free ranging mammals. Many of these requests involve animals living near humans, animals acting out of character or animals showing no fear of humans. Under the proposed action, WS could provide both technical assistance and direct operational assistance to these persons. WS could also conduct or assist with the monitoring or surveillance of diseases in wild and free ranging mammals addressed in this EA. Most disease sampling would occur ancillary to other wildlife damage management activities (i.e., disease sampling occurs after wildlife have been captured or lethally taken for other purposes). WS may also sample mammals captured or lethally taken by private or other government entities or dying from other causes (e.g., collisions with vehicles). For example, WS may sample feral swine taken by private individuals for zoonotic or other diseases.

This section includes brief descriptions of examples of zoonotic diseases for which WS could provide surveillance or management assistance. Additional examples of zoonotic diseases, their animal host and how humans become exposed are displayed in Table 1.2. Hosts are organisms that harbor or carry pathogens either externally or internally (e.g., parasites). This discussion is intended to briefly address the more common known zoonotic diseases associated with those species addressed in this EA. It is not intended to be an exhaustive discussion of all potential zoonotics. The transmission of many zoonotic diseases from wildlife to humans is neither well documented nor well understood. Determining a vector for a human infected with a disease known to occur in wildlife populations is often complicated by the presence of the known agent across a broad range of naturally occurring sources. For example, a person with salmonella poisoning may have contracted salmonella from direct contact with an infected pet, but may have also contracted the bacteria from eating undercooked meat or from other sources. Consequently, this list is not all-inclusive and new diseases may be identified in the future or may be introduced from other geographic areas.

Table 1.2 – Animal diseases that pose potential human health and safety risks through transmission to humans (Davidson 2006, Miller et al. 2013, Conover and Vail 2015).

Disease (causative agent)	How humans contract	Hosts[1]
Anthrax (*Bacillus antracis*)	Direct contact, ingestion, inhalation	Various mammals
Brucellosis, bovine (*Brucella abortus*)	Direct contact, ingestion, inhalation	Feral swine, coyotes, others
Brucellosis, swine (*Brucella suis*)	Direct contact, ingestion, inhalation	Feral swine, rodents, others
Dermatophilosis (*Dermatophilus congolensis*)	Direct contact	Various mammals
Echinococcosis/ hydatidosis (*Echinococcus multilocularis*)	Ingestion	Canids[2], felids[3], cervids[4], rodents, rabbits

Ehrlichiosis (*Ehrlichia* species)	Bite of infected tick, possible direct contact or inhalation	Various mammals
Giardiasis (*Giardia* species)	Ingestion	Beavers, coyotes, dogs, cats, muskrats, rodents
Leptospirosis (*Leptospira interrogans*)	Direct contact, ingestion, inhalation	Rodents, raccoons, skunks, opossums, nutria
Lyme (*Borelia burgdorferi*)	Bite of an infected tick	Various mammals
Mange, demodetic (*Demodex odocoilei*)	Bite of infected mite	White-tailed deer
Mange, scarcoptic (*Scarcoptes scabiei*)	Bite of infected mite	Coyotes, foxes
Plague (*Yersinia pestis*)	Bite of infected flea, inhalation	Chipmunks, carnivores, cats, rabbits, squirrels, others
Rabies (*Rhabdovirus*)	Direct contact, inhalation	Various mammals
Raccoon roundworm (*Baylisascaris procyonis*)	Ingestion	Raccoons
Rocky Mountain Spotted Fever (*Rickettsia rickettsii*)	Bite of infected tick	Various mammals
Salmonellosis (*Salmonella* species)	Ingestion	Cats, dogs, feral swine, others
Trichinellosis, Trichinosis (*Trichinella spiralis*)	Consumption	Carnivores, feral swine, raccoons, rodents, bears, others
Tularemia (*Francisella tularensis*)	Bites of infected fleas and ticks, consumption, direct contact, inhalation	Beavers, rabbits, muskrats, rodents, others
Typhus, Epidemic (*Rickettsia prowazekii*), Murie typus (*Rickettsia typhi*)	Bite of infected lice or fleas, direct contact, inhalation	Rodents, others
Spirometra (*spirometra mansonoides*)	Ingestion	Bobcats, cats, dogs, foxes, raccoons, others

[1]The use of the general term "*mammals*" as the host species denotes zoonotic diseases that could infect a broad range of mammals.
[2]Canids include dogs, coyotes, and foxes
[3]Felids include cats, bobcats
[4]Cervids include deer and elk

Tularemia is a disease caused by the bacterium *Francisella tularensis* (CDC 2015*b*). Usually, people become infected through the bite of infected ticks or flies, by handling infected sick or dead animals, by eating or drinking contaminated food or water, or by inhaling airborne bacteria. An average of 142 human cases of tularemia were reported each year in the U.S. from 2005 to 2014 (CDC 2015*c*). Most cases occur in south-central and western states; however, cases have been reported in every state except Hawaii. Without treatment with appropriate antibiotics, tularemia can be fatal (CDC 2015*d*). The causative agent of tularemia is one of the most infectious pathogenic bacteria known. The Working Group on Civilian Biodefense considers tularemia to be a dangerous potential biological weapon because of its extreme infectivity, ease of dissemination, and substantial capacity to cause illness and death (Dennis et al. 2001). Many wild animal species may be infected (hares, rabbits, squirrels, muskrats, beavers, deer), and occasionally certain domestic animals can also be infected (sheep and cats). However, rabbits are the species most often involved in disease outbreaks. The bacteria can also be found in ticks and flies. Tularemia in humans is relatively rare in Delaware, with eight cases identified between 2000 and 2014 (CDC 2009b, CDC 2015c). The most recent verified case occurred in 2011 (CDC 2015c).

Rabies is an acute, fatal viral disease of mammals most often transmitted through the bite of a rabid animal. Rabies is preventable, but it is fatal without prior vaccination or post-exposure treatment. All mammals, including humans, are susceptible to rabies. Over the last 100 years, the way rabies in the U.S. is transmitted to humans has changed dramatically. About 90% or greater of all animal cases reported annually to CDC now occur in wildlife (Krebs et al. 2000, CDC 2011*b*). Before 1960, the majority of cases were reported in domestic animals. The principal rabies hosts today are wild omnivores and bats. The number of rabies-related human deaths in the United States has declined from more than 100 annually in the early 1900s to an average of one or two people per year in the 1990s. Modern day treatment, which involves a series of injections given to people who have been or potentially have been exposed, has proven nearly 100% successful in preventing mortality when administered promptly (CDC 2011*b*). In the United States, human fatalities associated with rabies occur in people who fail to seek timely medical assistance, usually because they were unaware of their exposure to rabies. Although human rabies deaths are rare, the estimated public health costs associated with disease detection, prevention, and control have risen, exceeding $300 million annually. Those costs include the vaccination of companion animals, maintenance of rabies laboratories, medical costs such as those incurred for exposure case investigations, rabies post-exposure injections, and animal control programs (CDC 2011*b*). From 2010 to 2016, Delaware performed 1,073 rabies tests. During that seven year period there were 71 confirmed cases of rabies which is an average of 10 per year. Raccoons were the most common species that tested positive with 25 positive cases between 2010-2016 (DHSS 2016). A recent study in Pennsylvania found that the number of rabid cats and the number of human exposures to rabies because of an interaction with an unvaccinated rabid cat has steadily risen (Campagnolo et al. 2013). In the study, humans were more likely to come into contact with a rabid cat (29% of human exposure cases) than any other animal except raccoons (35% of human exposure cases) (Campagnolo et al. 2013). WS' involvement in rabies research and management is addressed in the WS nationwide EA on rabies management (USDA 2009*a*).

Numerous tick borne diseases have been documented in and around Delaware including Lyme disease, ehrlichiosis / anaplasmosis, Rocky Mountain spotted fever, Tidewater spotted fever, tularemia and Powassan virus. Lyme disease has been documented in Delaware with 6,270 cases from 2005-2014 which is an average of 627 cases annually (CDC 2016c). Blacklegged ticks (*Ixodes scapularis*) which transmit Lyme disease to humans infest a wide variety of animals, but are most commonly found on meadow voles, mice, and white-tailed deer. Spotted Fever Rickettsiosis (SFR) is a category that captures cases of Rocky Mountain spotted fever, *R. parkeri* rickettsiosis, Pacific Coast tick fever, and rickettsial pox. The number of cases of SFR reported to CDC per year have increased from 424 cases in 1993 to

4,470 cases reported in 2012. Delaware was in the top 24% of states with incidence rates of SFR during 2014 (CDC 2017).

Raccoon roundworm is a parasite commonly found in the small intestine of raccoons which causes severe or fatal encephalitis in a variety of mammals, including humans (CDC 2011*a*). It also causes eye and organ damage in humans. Humans become infected by ingesting soil or other materials (e.g., bark or wood chips) contaminated with raccoon feces and roundworm eggs. Young children are at particular risk for infection as a result of behaviors such as placing potentially contaminated fingers and objects like toys into their mouths (CDC 2012*b*). Raccoons are the primary host for the roundworm, but other animals can become infected. Although cases are rare with fewer than 25 cases occurring in the U.S. (CDC 2012*b*), infection can be serious. As of 2012, there were 16 reported human neurological cases of raccoon roundworm in the U.S.; six of these persons died (CDC 2012*b*).

Feral swine are potential reservoirs for a plethora of viral and bacterial pathogens and parasites. Diseases that have been detected in feral swine that can infect humans include brucellosis, leptospirosis, salmonellosis, toxoplasmosis, trichinosis, trichostrongylosis, sarcoptic mange, (Seward et al. 2004), tuberculosis, tularemia (Hubálek 2002, Stevens 2010), anthrax, rabies (Luangtongkum et al. 1986) and plague (Beach 1993). Infection may occur from direct exposure to swine by handling live animals or carcasses (CDC 2009), through ingestion of undercooked pork, contaminated water or food crops (Jay et al. 2007). It can also occur when feral swine infect another host (e.g., domestic or wild animal) which then infects a person (West et al. 2009). Feral swine may also play a role in the emergence of new diseases, acting as re-assortment vessels for viruses such as H2N3 swine-specific virus. The reassortment of viruses could lead to new strains of influenza viruses that would become easily transferrable from other mammals to humans (Brown 2004). Although incidence of disease transmission from feral swine to humans is relatively uncommon, some diseases like brucellosis, tuberculosis, and tularemia can be fatal if left untreated.

This section includes only some examples of zoonotic diseases for which WS could provide surveillance or management assistance. It is not intended to be an exhaustive discussion of all potential diseases for which WS could provide assistance.

Threat of Aircraft and Vehicles striking animals

Collisions between aircraft or vehicles and animals are a concern throughout the world because of the hazards they pose to human health and safety. Mammals of all sizes can be involved in collisions. Injury or death can occur when vehicles strike mammals or when drivers or pilots try to avoid a collision with a mammal.

From 1990 to 2013, aircraft strikes with terrestrial mammals were reported 3,149 times in the U.S. (Dolbeer et al. 2014). A total of 1,028 (33 percent) of these were reported to have caused damage to the aircraft (Dolbeer et al. 2014). However, the number of mammal strikes actually occurring is likely to be much greater, since an estimated 80% of civil aviation wildlife strikes with wildlife go unreported (Cleary et al. 2000). These incidents can pose serious threats to human safety. For example, damage to the landing gear during landing or takeoff can cause a loss of control of the aircraft. Across the entire U.S. for the 24 year reporting period of injury-causing strikes, white-tailed deer were involved in 20 strikes that caused 27 injuries and one death, dogs were involved in one strike that injured two people and Eastern cottontail were involved in one strike that injured one person (Dolbeer et al. 2014).

From 1990 to 2015, aircraft strikes with terestrial mammals have caused over $60 million of economic loss in the U.S. and over 317,000 aircraft downtime hours (FAA 2015). In Delaware since 1994, aircraft

have reported striking two white-tailed deer (FAA 2015). The infrequency of mammal strikes does not lessen the need to prevent threats to human safety.

In addition, some species addressed in this EA pose minimal strike hazards at airports but their presence on airport property can attract other species which pose higher risks of aircraft strikes. For example, a high density of insectivores, rodents and cottontail rabbits on airport property are a food source and therefore an attractant for many predator species. For example, raptors often pose a high risk to aircraft due to their relative size and their soaring and hovering behavior. Therefore, reducing rabbit densities at airports can reduce risks of strikes with raptors by reducing the availability of a food source.

Similar to strikes between mammals and aircraft, many strikes between vehicles and mammals are unreported (Romin and Bissonette 1996). The CDC estimated that 26,647 people were injured per year in collisions with animals (mostly deer) and an additional 10,000 people are injured annually when drivers take evasive action to avoid a collision (CDC 2004). Using a data set from Utah, Bissonette et al. (2008) found that 94.7% of collisions with deer resulted in no injury, 2.2% in possible injury, 1.8% in bruises and abrasions, 1.2% in broken bones or bleeding, and 0.04% in death. Of those people receiving injuries, 4.2% were treated at an emergency medical facility. Average cost of treatment to these people was $2,237. More than 200 human fatalities occur as a result of deer-vehicle collisions every year (Conover 1997). Other mammals involved in fatalities include dogs, bears, cats and opossum (Williams and Wells 2005). The possibility exists for any collision with a mammal or any evasive action taken by a driver to avoid a collision with a mammal to result in human injury or death. However, the risk of injury or death increases with the size of the mammal. In general, animals with larger body sizes are a greater risk to human health and safety than those that are smaller (Williams and Wells 2005). In 2015, Delaware documented a total of 1,791 deer-vehicle collisions, which was over a 5% increase from 2014 logged by the police departments. The 2015 crashes resulted in two fatalities, 63 personal injuries and 1,726 property damage cases (Delaware.gov 2016).

Threat of Compromised Infrastructure

Burrowing by beavers, muskrats, and woodchucks and damming by beavers can cause significant damage and or destruction to infrastructure, including foundations, roads, railways, dams, dikes, levees, storm water retention ponds, and bridges which in turn threatens human health and safety (Woodward 1984, Bollengier 1994, Miller 1994, Miller and Yarrow 1994). Damage caused by beavers often occurs when beavers plug culverts that allow water to pass beneath a roadway or when they impound water which washes out, undermines or floods roads or railroad beds. Culverts and the surrounding infrastructure which support the roadbed are not built to withstand the strong pressure and scouring action that occurs when water is forced into a narrow channel and cannot pass through culverts (because the beaver has erected a dam). This condition can lead to the washout or collapse of the road or railway bed which may not always be apparent until tested by the weight of a vehicle or train. In 1984, five people died and 26 were seriously injured when an Amtrak train derailed after beaver activity caused a flash flood that undermined the track (Associated Press 1985). Damming of culverts can also lead to flooding of the roadway which can cause cars to hydroplane and crash (Georgia Department of Transportation V. Miller et al.). Beavers, muskrats and woodchucks dig burrows or networks of burrows, which can weaken structures such as dams, dikes or levees which collapse when people or animals walk on them, when vehicles or heavy equipment (e.g., mowers, tractors) drive over them, or when tested by high water (Armitage 2003, Baker and Hill 2003, Bollengier 1994, Erb and Perry 2003, Miller 1994, Miller and Yarrow 1994). Such incidents can threaten the safety and lives of people on the dam or levee as well as those people downstream from the dam or protected by the levee.

Additional human safety concerns

Humans are increasingly living in close proximity to wildlife. This closeness coupled with a lack of harassing and threatening behavior by people toward wildlife has led to a decline in the fear wildlife have toward people. When wildlife species begin to habituate to the presence of people and human activity, a loss of apprehension occurs that can lead to threatening behavior toward people. This threatening behavior continues to increase as human populations expand and the populations of those species that adapt to human activity increase. Threatening behavior can be in the form of aggressive posturing, a general lack of apprehension toward people, or abnormal behavior. Although animals attacking people occurs rarely, the number of attacks appears to be on the increase.

From 1960–2006, a total of 159 people were bitten by coyotes in the U.S. and Canada (White and Gehrt 2009). Of these, most (37%) were classified as predatory ("incidents in which a coyote directly and aggressively pursued and bit a victim"), followed by investigative (22%) (a habituated coyote bit people who were sleeping or resting), rabid (7%) (animal tested positive for rabies), pet related (6%) (a pet was present), and defensive (4%) (coyote was cornered or defending pups) (White and Gehrt 2009). A study conducted in the Denver Metropolitan Area classified not just incidents that resulted in bites but also any incident that resulted in physical contact between people and coyotes from 2003 to 2010 (Poessel et al. 2013). Of these, six (41.1%) involved situations in which pets were associated with the incident, four (30.8%) did not involve pets and three (23.1%) did not have any additional information (Poessel et al. 2013). Two deaths in the U.S. and Canada have been attributed to coyotes. A young child in California in 1981 (Howell 1982) and a 19-year old woman in Nova Scotia in 2009 (Canadian Broadcast Company 2009).

A variety of other mammals addressed in this EA can also threaten human health and safety. For example feral swine have attacked hunters, dog walkers, golfers, picnickers and people recreating in urban and suburban environments (Mayer 2013). Four fatal feral swine attacks have been documented in the U.S. (Mayer 2013). Although attacks on people associated with those species addressed in this EA occur rarely, requests for assistance to lessen the threat of possible attacks could occur. Often, animals exhibiting threatening behavior or a loss of apprehension to the presence of people is a direct result and typically is an indication of an animal inflicted with a disease. Therefore, requests for assistance could occur from a desire to reduce the threat of pathogen transmission, from a fear of aggressive behavior from an animal that does not show a fear of people, or from a fear of aggressive behavior from an animal that is exhibiting aggressive behavior caused by disease (e.g., rabies).

Need for Mammal Damage Management to Resolve Damage to Agricultural Resources

Requests received by WS for assistance in reducing or preventing damage or threats of damage from mammals to agriculture falls into three categories: crops, livestock and other resources. Farming is an important industry in Delaware with approximately 500,000 acres devoted to agricultural production in 2016 (NASS 2016).

Damage and Threats to Agricultural Crops

In 2012, agricultural crops sold in Delaware had a market value estimated at 429 million dollars (NASS 2016). Sales of grains, oilseeds, dry beans and peas in 2012 totaled 345 million dollars, while sales of vegetables, melons, potatoes and sweet potatoes totaled 60 million dollars (NASS 2016). Other important crops include nurseries and sod (NASS 2016). All of these crops are vulnerable to wildlife damage.

Reports of wildlife damage to agricultural crops have increased over time (Conover and Decker 1991). In its most recent survey of agricultural losses to wildlife, conducted in 2002, the National Agricultural

Statistics Service (NASS), reported that nationwide, field crop losses to wildlife totaled 619 million dollars and losses of vegetables, fruits and nut totaled 146 million dollars (NASS 2002). This damage is not evenly distributed among agricultural producers (Wywialowski 1994, Brown et al. 2004).

Surveys in other eastern states have indicated that anywhere from 32% to 71% of farmers experience deer damage (Brown et al. 1978, Decker and Brown 1982, Tanner and Dimmick 1984, Sayre et al. 1992, West and Parkhurst 2002). Nationwide white-tailed deer account for the majority of field crop, vegetable, fruit, and nut damage (Conover 1998, NASS 2002). Crops can account for as much as 78% (by mass) of a white-tailed deer's diet (Smith 1991). White-tailed deer cause damage to a variety of crops including but not limited to: corn, soybeans, forage crops (e.g., alfalfa, hay etc.), grain crops, vegetables (e.g., tomatoes, potatoes, pumpkins, melon), peanuts, nursery plants, orchards (e.g., fruit trees, nut trees, maple trees for syrup production), vineyards, berries, timber, and Christmas trees (de Calesta and Schwendeman 1978, Tanner and Dimmick 1984, Scott and Townsend 1985, Vecellio et al. 1994, Wywialowski 1996, ODNRDW 2001, Tzilkowski et al. 2002, Brown et al. 2004, MacGowan et al. 2004, DeVault et al. 2007, Colligan et al. 2011, Ober et al. 2014). Damage is caused not only when deer directly consume plant parts but also when deer trample or rub their antlers on small trees and which can kill plants outright or cause permanent disfigurement (Harder 1970, Scott and Townsend 1985, Craven and Hygnstrom 1994, Lemieux et al. 2000). For example, deer will browse on the newly emerged growth of young conifers (ODNRDW 2001). When the vertical branch at the top of the tree is consumed on young Christmas trees it often causes permanent disfigurement that renders the tree unmarketable.

After white-tailed deer, woodchucks caused the second-largest amount of damage in a New Jersey assessment (Drake and Grande 2002), but in contrast were only cited as causing damage by 9 to 20% of farmers surveyed across the Northeast and Mid-West (Wywialowski 1994). Woodchucks are responsible for damage to soybeans, corn, alfalfa, a variety of vegetables (e.g., beans, cabbage, squash, peas, watermelons), nursery plants and fruit trees (Bollengier 1994, Curtis and Sullivan 2001, ODNRDW 2001, Tzilkowski et al. 2002, DeVault et al. al. 2007). Damage is caused not only when plants are directly consumed but when plants such as fruit trees are stunted or killed by woodchucks chewing the bark or when the weight of the animal climbing the plant causes the structure of the plant to break (e.g., corn stalks snap) (Curtis and Sullivan 2001, ODNRDW 2001).

Raccoons can cause significant damage to corn, turf grass / sod farms, and variety of vegetable and orchard crops (Craven and Hygnstrom 1994, DeVault et al. 2007). Humberg et al. (2007) found that raccoons were responsible for 87% of the damage to corn in Indiana. Raccoons cause crop damage when they consume developing seedlings, when they consume the harvestable crop (ears of corn, melons, tomatoes etc.), or when the weight of the animal climbing the plant causes the plant to break (e.g., corn stalks snap) (Craven and Hygnstrom 1994, ODNRDW 2001).

Eastern cottontails can cause considerable damage to vegetables (e.g., peas, beans, beets, carrots etc.), nursery plants, orchards (e.g., fruit trees, nut trees), berries, timber, and Christmas trees (Craven 1994, Williams and Short 2014). In Nebraska, rabbits and hares caused an estimated 2.2 million dollars in crop damage and destroyed approximately 500 acres of timber plantations annually (Williams and Short 2014). Damage is caused not only when plant parts are directly consumed but also when cottontails gnaw the bark which stunts or kills the plant (Craven 1994). Extensive damage can result when snow allows access to plant parts at a variety of heights above ground level (Craven 1994).

Feral swine accounted for an estimated $18.5 million in damages to field crops in 2002 (NASS 2002). Field crops damaged by feral swine include but are not limited to: corn, soybeans, forage crops (e.g., alfalfa, hay etc.), grain crops, vegetables (e.g., lettuce, spinach, melons, pumpkins, watermelons), peanuts, cotton, orchards, vineyards, berries, timber and Christmas trees (Schley and Roper 2003, Seward et al. 2004, West et al. 2009). Feral swine damage crops through direct consumption and other behaviors, such

as rooting, trampling, and wallowing, which can result in destruction of fields or reduction of productivity. For example, rooting and trampling of seedlings impacts regeneration of timber plantations (Lipscomb 1989) and rooting and trampling in orchards can retard mature tree growth or cause a decline in harvest (Campbell and Long 2009).

Striped skunks can cause substantial damage to turf grass /sod farms. As skunks forage for insects and earthworms, they dig hundreds of holes (ODNRDW 2001). Skunks also consume seedlings and occasionally corn (Knight 1994, ODNRDW 2001). Virginia opossum can cause crop damage by consuming vegetables (e.g., tomato), fruits, nuts, and berries (Baldwin 2015).

Tree squirrels (gray and fox) can cause damage to orchards when they consume the flowers that will become fruit or nuts or when they consume or remove the fruit or nut crop (Jackson 1994*a*). Tree squirrels may also damage orchard trees by chewing or stripping the bark (Jackson 1994*a*). Additionally, tree squirrels damage nursery plants, timber and Christmas trees when they clip the ends of branches or strip the bark off branches or the trunk (ICWDM 2015). Squirrels also cause damage when they consume corn seedlings, ripening, mature or stored corn (ODNRDW 2001).

Most beaver damage to crops, including field crops, nursery stock, orchards and timber occurs when beavers' dam building behavior results in flooding (Miller and Yarrow 1994). Beavers also cause damage when they consume the leaves, twigs and bark of plants or cut down trees (Miller and Yarrow 1994). Beavers will travel more than 100 yards to consume corn and other crops and use the rest of it as dam construction material (Miller and Yarrow 1994). Muskrat will also consume field crops including corn, wheat, oats, grain sorghum (milo) etc. (LeBlanc 1994, Miller 1994).

Canids, including coyotes, like sweet substances (Mason and Bloom 1998). As a result coyotes can cause significant damage to sweet corn and watermelons (Green et al. 1994, Armstrong and Walters 1995).

Damage and Threats to Livestock

Disease

Although the source of disease outbreaks can be difficult to identify, a risk of pathogen transmission exists wherever wild or free ranging mammals and livestock interact or use the same resources such as water or feed (Berentsen et al. 2014). Of the animal diseases that occur in the U.S., 72% (42) are presumed to require wildlife to transmit, maintain or complete the life cycle of the pathogen (Miller et al. 2013). Of these, six are so common in wildlife and their ability to infect domestic animals so common that it impedes their eradication (Miller et al. 2013). The role wildlife plays in livestock diseases is expected to increase (Siembieda et al. 2011). Diseases which can be transmitted from wild or free ranging mammals to livestock may be bacterial, spirochetal, rickettsial, viral, fungal, prions or parasites. Examples of diseases, the livestock they affect and the animal hosts are displayed in Table 1.3. Livestock diseases cause loss through morbidity, mortality, decreased production, decreased feed efficiency, lower reproductive success, and the costs associated with veterinary diagnostics and treatment.

Studies suggest that cattle in a five county area in Michigan became infected with *Mycobacterium bovis*, the mycobacterium that causes tuberculosis (TB) when they shared resources or interacted with white tailed deer (Berentsen et al. 2014). Infection can occur through inhalation of aerosolized bacteria or nose-to-nose contact but studies also suggest indirect contact which results when cows and deer share feed may be a mechanism which spread *Mycobacterium bovis* between individual deer and between deer and cattle. Transmission between farms is thought to occur via white-tailed deer and not the transfer of cattle (Berensten et al. 2014). When the cattle in Michigan became infected, the state loss its TB accreditation status which has resulted in agricultural and livestock losses valued at $12 million dollars a year (Horan and Wolf 2005).

Coyotes, dogs, foxes and other canids host *Neospora caninum*, a protozoan parasite that 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) detected statistically significant associations between the density coyotes and grey foxes with the number of infected cattle.

Transmitted via a bite or saliva from an infected mammal, the rabies virus is fatal once symptoms appear (CDC 2012*b*). Rabies is a serious concern for livestock producers (Conover and Vail 2015). Infection of two cattle herds in Ohio and West Virginia resulted in $44,000 and $103,000, in costs to the public and producers, respectively (Chipman et al. 2011). In one of these cases, cows had been observed smelling and licking a skunk and in both cases the cattle tested positive for the raccoon rabies variant. Costs included market value of cattle that died or had to be euthanized (64 cattle in Ohio and 88 cattle in West Virginia), costs associated with government response, cost of vaccination to persons exposed to infected cattle, costs of carcass disposal and laboratory testing (Chipman et al. 2011). All mammals can be infected with rabies making most types of livestock susceptible (Conover 2002).

Ticks harbored by wildlife and free ranging mammals can carry both spirochetal and rickettsial diseases (Conover and Vail 2015) transferrable to livestock. For example, Lyme disease caused by a spirochetal bacterium (*Borrelia burgdorferi*) can infect cattle, horses and other livestock via a bite from a black legged tick (Parker and White 1992). Symptoms include chronic weight loss, lameness, swollen joints, behavioral changes and decreased milk production in cows (Parker and White 1992). Anaplasmosis is caused by the rickettsial bacteria *Anaplasma phagocytophilum* and can similarly infect livestock via a bite from a black-legged tick (Conover and Vail 2015). The disease causes abortions, still births, decreased semen quality and impaired immune systems in infected sheep, goats and cattle (Conover and Vail 2015).

Feral swine can carry more than 30 viral and bacterial pathogens, and approximately 40 parasites that may affect domestic livestock, humans, and wildlife species (Ruiz-Fons et al. 2008, Meng et al. 2009). For example, porcine reproductive and respiratory syndrome is a highly infectious virus that causes reproductive failure and respiratory disease in swine (USDA 2009). The total cost of productivity losses due to porcine reproductive and respiratory syndrome in the domestic swine herd in the United States was estimated at $664 million annually during 2011 (Holtkamp et al. 2013). Pseudorabies is a viral disease associated with an extremely contagious herpes virus that can have negative effects on reproduction in domestic swine. An economic analysis estimated that the annual cost of pseudorabies to pork producers in the United States at more than $30 million annually in lost production as well as testing and vaccination costs (USDA 2008).

Table 1.3: Additional wildlife diseases with mammalian hosts that pose threats to livestock in the United States (modified from Miller et al. 2013)

Disease	Affected livestock	Hosts*
Anthrax	Cattle, sheep, goats, horses, swine	All mammals
Aujeszky's disease	Swine, cattle, sheep, goats, horses	Feral swine, other mammals
Blue tongue	Sheep, goats, cattle	Cervids[1], others
Bovine anaplasmosis	Cattle	Cervids[1]
Bovine genital campylobacteriosis	Cattle	Numerous
Bovine viral diarrhea	Cattle, bison, camelids[2]	White-tailed deer, others
Brucellosis (*Brucella abortus*)	Cattle, sheep, horses	Feral swine, others
Brucellosis (*Brucella suis*)	Swine, horses	Feral swine, rodents, others
Echinococcosis/ hydatidosis	Sheep, cattle	Canids[3], felids[4], cervids[1], rodents, rabbits
Epizootic hemorrahagic disease	Cattle, sheep	White-tailed deer, others
Equine encephalomyelitis (eastern and western)	Equids[5], repots of cattle, sheep, camelids and pigs	Rodents, white-tailed deer, others
Infectious bovine rhinotracheitis/infectious pustularvulvovaginitis	Cattle	Several implicated
Leptospirosis	Cattle, sheep, goats, pigs, horses, others	Rodents, raccoon, skunk, opossum, nutria
Maedi-visna	Sheep, goats	Ruminants[6]
Myxomatosis	Rabbits	Rabbits
Paratuberculosis	Cattle, sheep, goats	Ruminants[6], rabbits, others
Q fever	Cattle, sheep, goats	Numerous
Rabbit hemorrhagic disease	Rabbits	Rabbits
Transmissible gastroenteritis	Swine	Feral swine
Trichinellosis (trichinosis)	Swine	Carnivores, feral swine, rodents, bears, others
Tularemia	Sheep, horses, pigs	Rabbits, muskrats, rodents, others
Vesicular stomatitis	Cattle, swine, equids, camelids, sheep, goats	Numerous
Chronic wasting disease	Domestic cervids[1]	Wild cervids[1]
Malignant catarrhal fever	Cattle, bison, swine, sheep, goats	Cervids[1], wild ovine species
Plague	Numerous	Chipmunks, carnivores, others

*Host species listed here only include those animals addressed in this EA.
[1]Cervids include deer and elk
[2]Camelids include llamas and alpacas
[3]Canids include dogs, coyotes, and foxes
[4]Felids include cats, bobcats
[5]Equids include horses, donkeys, and mules
[6]Ruminants include cattle, sheep, goats and deer

Predation

The number of cattle and calves grown by the livestock industry in Delaware totaled 18,225 in 2012 with an additional 6,157 horses and ponies (NASS 2016). Although cattle industries are more likely to incur losses, livestock producers in Delaware also raised 6,157 horses and ponies as well as 43 million broilers and other meat-type chickens (NASS 2016).

Grey fox predation occurs to both sheep and lambs although predation of lambs is more common (Wade and Bowns 1982). Raccoons (Acorn and Dorrance 1990, Boggess 1994*a*), opossums, skunks (Acorn and Dorrance 1990, Knight 1994), and other mammals are also predators of livestock, especially fowl and their eggs. Skunks also damage beehives when they attempt to feed on bees (Knight 1994). Raccoons, otters, muskrats and, to a lesser extent, foxes and other mammals may prey on fish and other cultured species at aquaculture (freshwater and marine) facilities (Parkhurst et al. 1987, Goldburg et al. 2001).

Feral swine can kill calves, goat kids, lambs, and poultry (West et al. 2009, Stevens 2010, USDA 2015*a*). Predation primarily occurs to young livestock but feral swine will also kill adult animals (Wade and Bowns 1982). Even when predation is considered, feral swine often escape suspicion because people generally underestimate their capabilities as a predator (Beach 1993).

Damage and Threats to Other Agricultural Resources

Mammals cause damage to other agricultural resources besides crops and livestock. For instance many species can cause agricultural damage when they consume, contaminate or destroy stored grain, feed, or seed (Wywialowski 1994). Feral swine damage pasture and soil structure through rooting, trampling, wallowing and compaction (Seward et al. 2004, West et al. 2009). These changes in soil properties and water infiltration rates can lead to flooding of crop or pasture land or erosion and damage to water sources (West et al. 2009). Feral swine consume and contaminate livestock feed and mineral sources and also damage farm infrastructure such as fences, irrigation ditches, and other structures (Seward et al. 2004, West et al. 2009). Additionally, rooting and wallowing creates holes that if unnoticed can damage farming equipment (West et al. 2009).

Damming by beavers can cause significant damage to crops and agricultural infrastructure (Miller and Yarrow 1994). In some instances, thousands of acres of crop land have been flooded by beavers (Miller and Yarrow 1994). Additionally, beavers, muskrats, and woodchucks dig burrows or networks of burrows, which can weaken structures such as dams, dikes or levees or similar agricultural infrastructure and cause damage when they collapse injuring livestock, damaging farming equipment or flooding crops or property used for agriculture (Armitage 2003, Baker and Hill 2003, Leblanc 1994). Gray squirrels can cause considerable damage to maple sugar tubing systems by gnawing on the tubes to consume the sugar water (May et al. 1992, Williams and Corrigan 1994). Woodchucks and coyotes cause similar damage to rubber hoses used in irrigation (Connolly 1992, Bollengier 1994).

Need for Mammal Damage Management to Resolve Damage to Natural Resources

Mammals can negatively affect natural resources through habitat degradation, competition with other wildlife, direct depredation, and other factors. Habitat degradation occurs when large concentrations of animals in a localized area negatively affect characteristics of the surrounding habitat, which can then adversely affect other wildlife species. Competition occurs when species compete for available resources, such as food or habitat. Direct depredation occurs when predatory mammal species feed on other wildlife species, which can negatively influence those species' populations, especially when depredation occurs on threatened and endangered species. Examples of these types of damage and threats which occur or could occur in Delaware include but are not limited to the following examples.

Damage and Threats Caused by Predation

Delaware's coastal areas provide critically important habitat for nesting colonial waterbirds and shorebirds including the piping plover (*Charadrius melodus*), American oystercatcher (*Haematopus palliatus*) and least terns (*Sternula antillarum*). In 2017, there were nine nesting pairs of plovers in

Delaware which are listed and protected under the Endangered Species Act (ESA) (Wilson 2017). However, threats including habitat loss and degradation, rising sea level, severe weather events, human disturbance, competition with other species and predation jeopardize these populations (Davis et al. 2001, Erwin et al. 2011). Managing variables that are controllable (predator and competitor species, human disturbance) helps offset variables that are not within our control (weather, sea level rise). Predation continues to be a significant and manageable factor limiting recovery of many species of birds nesting on barrier islands and sensitive seashores.

The presence of even a single predator at a nest site can result in the direct mortality of adult birds, chicks and eggs or cause birds to abandon active nests and the nesting site entirely (Erwin et al. 2011, Kress and Hall 2004). Virginia opossum, coyote, fox, raccoon, striped skunk, rodents (i.e., rats) and other mammals are known or suspected to reduce breeding success of piping plovers (Patterson et al. 1991, Boettcher et al. 2007, Daisey 2009, Wilke 2011, Wilke 2012, USFWS 2014), American oystercatchers (Nol 1989, Erwin et al. 2001, Wilke et al. 2007, Daisey 2009, Schulte et al. 2010, Denmon and Tarwater 2011, Wilke 2011, Denmon and Chapman 2012, Wilke 2012, Denmon et al. 2013), black skimmers (*Rynchops niger*) (Daisey 2009), terns (*Sterna* spp.) (Erwin et al. 2001, Kress and Hall 2004, Daisey 2009, Erwin et al. 2011, USFWS 2014) and other seabirds (Burger and Gochfeld 1991, Brinker et al. 2007, Daisey 2009, Wilke 2012). Boettcher et al. (2007) found that predation is a primary threat facing the recovery of the piping plover and the American oystercatcher in Virginia (Boettcher et al. 2007, Wilke et al. 2007). Mammalian predation can be solely or primarily responsible for the failure (100% of nests lost) of a colony of nesting colonial waterbirds or localized population of shorebirds during a given year (Patterson et al. 1991, McGowan et al. 2005, Ellis et al. 2007). There is a general inverse relationship between the number of predators removed and the productivity of beach nesting birds in any given year (USFWS 2014). Therefore, reducing predation is an important action identified for the recovery of species which are threatened, endangered or otherwise imperiled (USFWS 1996).

Another shorebird that utilizes the Delaware Bay is the red knot (*Calidris canutus*). Knots are known for their long annual migrations from the Arctic breeding grounds to South America, which can be over 9,000 miles (USFWS 2005). During this long migration, large concentrations of red knots congregate in the Bay to feed on the eggs of spawning horseshoe crabs. This stopover usually only last for a few weeks while the birds take advantage of the crab eggs (Reshetiloff 2015). WS may be requested to protect these long distance travelers while they take advantage of a food supply that will aid them in successfully returning to their breeding grounds with optimum fat reserves from the Delaware shorelines.

Freshwater mussels are the most imperiled group of animals in the U.S. (Carey et al. 2015). Historically, over a dozen species of mussels were found in streams throughout the Delaware Estuary. However, recent studies show that there may only be a few species remaining in Pennsylvania, New Jersey and Delaware (deleware estuary inc). A combination of habitat destruction and alteration, damming and impoundment, loss of host fish (needed to complete their reproductive cycle), pollution, water quality degradation and the introduction of invasive species has compromised freshwater mussel populations' ability to sustain themselves when faced with competition, disease and predation (Edelman et al. 2015, Strayer et al. 2004). Predation is a significant factor which may limit the recovery of freshwater mussel species (Haag 2012, Hoggarth et al. 1995, Kopij 2011, Neves and Odom 1989). Raccoons, skunks, river otters, and muskrats will all predate freshwater shellfish (Tyrrell and Hornbach 1998, Williams et al. 2008). However muskrats are the species most documented as causing extensive predation to freshwater mussels including threatened and endangered species (Hanson et al. 1989, Neves and Odom 1989, Tyrrell and Hornbach 1998, Diggins and Stewart 2000, Owen et al. 2011, Hersey et al. 2013). Often, scientists are unable to find live rare mussels but find their remains present in muskrat middens (piles of shells created over time by muskrats discarding the shells of predated mussels) (Neves and Odom 1989, Owen et al. 2011). Reducing predation has been identified as an action to aid in mussel recovery (Neves and Odom 1989, Owen et al. 2011, Hersey et al. 2013, Edelman et al. 2015).

Feral swine are known predators of small mammals, white-tailed deer fawns, birds, snakes, turtles, salamanders, frogs, fish and a variety of invertebrates (West et al. 2009, Ballari and Barrios-Garcia 2014). In locations where species are struggling (e.g., threatened or endangered species), additional predation pressure by feral swine can threaten populations (Jolley et al. 2010). For example, Engeman et al. (2014) observed that once feral swine identify sea turtle and shorebird nests as a food source, all remaining nests are quickly predated. Managing this predation can dramatically improve nesting success (Engeman et al. 2014).

Damage and Threats to Habitat

Feral swine have a negative effect on "almost all aspects of ecosystem structure and function" (Jolley et al. 2010). The greatest damage occurs in areas that are environmentally sensitive or which provide critically important habitat for species which are listed under the ESA or are otherwise imperiled (Campbell and Long 2009). Much of this damage occurs through feral swine's rooting behavior (digging for food with their snout) which disturbs both the structure and properties of soil (Campbell and Long 2009). Rooting in conjunction with trampling and compaction, leads to the leaching of important minerals, changes in decomposition rates and nutrient cycling as well as increased rates of erosion (Campbell and Long 2009). This disturbance, along with the consumption of seeds and young plants by feral swine also changes the composition of vegetation on the landscape, the rate of plant regeneration and encourages exotic invasive plants (Singer et al. 1984, Campbell and Long 2009). Howe et al. (1981) found that feral swine rooting activities in the forest of Tennessee and North Carolina had occurred to the extent that recovery would take three or more years, while Bratton (1975) found that feral swine damage was so extensive that the forest understory was unlikely to ever recover. These changes in vegetation can be so extensive that they nearly wipe out local populations of native wildlife for which this vegetation provides critical habitat (Singer et al. 1984). This damage is most pronounced in areas that are more sensitive to disturbance such as aquatic environments (Seward et al. 2004, Kaller and Kelso 2006, Engeman et al. 2007, Kaller et al. 2007). Where feral swine cause erosion, increased turbidity, increased sedimentation, fecal contamination, nutrient mobilization, surface water enrichment as well as direct and indirect effects on aquatic biota and communities occurs (Zengel and Conner 2008).

Because white-tailed deer can occupy a variety of habitats and reproduce rapidly especially in the absence of native predators, their populations have increased sharply and in some areas have reached very high densities (Rooney and Waller 2003). Even in managed populations, deer densities regularly exceed those which existed at the time of European settlement (Rooney and Waller 2003). White-tailed deer are selective about what types of plants they consume (Strole and Anderson 1992). Therefore when deer populations are overabundant they can have substantial effects on individual plants, plant populations and communities (e.g., plant diversity and density) (Russel et al. 2001). These changes can lead to adverse effects on other species and natural ecosystems through food web interactions or habitat modification (Rooney and Waller 2003). For example, changes in plant diversity caused by overabundant deer can affect the diversity of insects (Murdoch et al. 1972, Haddad et al. 2001) which leads to a decrease in the number of insect predators (e.g., insect eating birds)(Nuttle et al. 2001). Changes in plant density can affect the structure and composition of the forest in the long term (de Calesta 1994, McShea and Rappole, 2000, Fuller 2001) which reduces the abundance, diversity and density of birds (de Calesta 1994, McShea and Rappole 2000) and nutrient cycling (Rooney and Waller 2003). Nuttle et al. (2001) concluded that even when deer are over abundant for a relatively short period of time they can cause disruptions to the structure and function of ecosystems for a century.

Beavers have a tremendous influence on ecosystem structure and function. For example, beaver dams slow water which increases the deposit of sediments and reduces the availability of invertebrates for fish to eat (Niles et al. 2013). Dams also lead to an increase in water temperature and a decrease in dissolved

oxygen which can be detrimental to some species of fish (Niles et al. 2013). Furthermore, dams can also restrict the movement of fish and isolate populations (Watters 1996). In order to reproduce, the life cycle of freshwater mussels requires that specific species of fish be present to act as hosts for parasitic immature mussels (different species of mussels require different species of fish) (VDGIF 2016). If the correct species of fish is not present, the freshwater mussel cannot reproduce. Additionally, the abundance and diversity of freshwater mussels is directly related to stream geomorphology and hydraulic conditions (Johnson and Brown 2000, Gangloff and Feminella 2007) which can be drastically altered by beavers (Rosell et al. 2005). Freshwater mussels are the most imperiled group of animals in the U.S. Beavers not only change aquatic environments but also the surrounding environment and habitat which effects the number and species of both plants and animals present (Rosell et al. 2005). This may occur both as a result of their construction of dams, burrows, canals and lodges as well as their harvest of or consumption of plant material (Rosell et al. 2005). A study conducted in Virginia showed that populations of Swamp Pink (*Helonias bullata*), a species of plant listed as threatened under the ESA, are highly vulnerable to the effects of beaver activity at U.S. Army Garrison, Fort A.P. Hill, in Virginia (Applegate et al. 2015).

Damage and Threats Caused by Competition

Feral swine negatively impact species of native wildlife by competing for resources (Seward et al. 2004, West et al. 2009). Many of the species listed under the ESA are at risk primarily because of competition or predation from exotic invasive species such as feral swine (Seward et al. 2004). Feral swine also compete with non-listed species of native wildlife such as white-tailed deer, black bears, wild turkeys (*Meleagris gallopavo*), raccoons and gray squirrels for acorns and other tree nuts (Henry and Conley 1972, Elston and Hewitt 2010). In some years this competition may be insignificant but in years in which resources are limited competition may be acute (Henry and Conley 1972). This is because feral swine not only have the ability to intake more food per unit of time and a wider diversity of food than species of native wildlife, but also because feral swine displace native wildlife from feeding sites and may comparatively be more efficient at digesting food (Elston and Hewitt 2010).

Competition between deer and other animals most often occurs when they share a common food resource (Rooney and Waller 2003). Authors have found that overabundant deer may compete with invertebrates to consume leaves and stems (Alverson and Waller 1997, Augustine et al. 1998, Rooney and Waller 2001), and with insects and various fruit and seed eating animals to consume flowers, fruits, seeds and nuts (Balgooyen and Waller 1995, McShea and Rappole 1992, Sargent 1990, Rooney 1997).

Threats Caused by Disease

Finally, mammals can negatively affect other wildlife through the transmission of disease. For example, Gehrt et al. (2013) concluded that the prevalence of *T. gondii* in the local skunk, raccoon and coyote population is likely a result of the presence of infected cats which act as hosts. Additional examples of diseases which occur or could occur in Delaware and cause damage or threaten wildlife populations include but are not limited to some of the same diseases that threaten human and livestock health (see ***Damage and Threats to Livestock****, Disease*).

Need for Mammal Damage Management to Resolve Damage to Property

Mammals have the ability to cause substantial damage to property. Examples of these types of damage and threats which occur or could occur include but are not limited to the following examples.

Damage Caused by Aircraft and Vehicles Striking Animals

Collisions between aircraft or vehicles and animals can result in significant damage. Mammals of all sizes can be involved in collisions. Damage can occur when vehicles strike mammals or when drivers or pilots try to avoid a collision with a mammal.

From 1990 to 2013, aircraft strikes with terrestrial mammals were reported 3,149 times in the U.S. (Dolbeer et al. 2014). A total of 1,028 (33%) of these were reported to have caused damage to the aircraft (Dolbeer et al. 2014). However, the number of mammal strikes actually occurring is likely to be much greater, since an estimated 80% of civil animal strikes go unreported (Cleary et al. 2000). These incidents can result in significant costs related not only to damage to the aircraft but also negative effects on flight. For example, strikes or near collisions can result in precautionary or emergency landings, evasive maneuvers, jettisoned fuel, and delayed or cancelled flights (Dolbeer et al. 2014). From 1990 to 2013, strikes with white-tailed deer in the U.S. caused $43.8 million dollars in total damages (Dolbeer et al. 2014).

In Delaware since 1994, aircraft have reported striking two white-tailed deer (FAA 2015). Minor damage to one airplane was reported after the deer struck the wing, rotor and landing gear. No injuries were reported (FAA 2015). The second strike in 2011 reported minor damage to the propeller, wing/rotor and landing gear. An engine fire was reported with the fire department responding (FAA 2015). The infrequency of mammal strikes does not lessen the need to prevent damage to aircraft. In addition, some species addressed in this EA pose minimal strike hazards at airports but their presence on airport property can attract other species which pose higher risks of aircraft strikes.

Similar to strikes between mammals and aircraft, many strikes between vehicles and mammals are unreported (Romin and Bissonette 1996). Using a data set from Utah, Bissonette et al. (2008) found that an average deer-vehicle collision resulted in $1,320 dollars in vehicle damages. Nationwide, it is estimated that more than 1 million deer-vehicle collisions occur in the U.S., resulting in vehicle damage costs that exceed $1.1 billion dollars (Conover et al. 1995, Conover 1997). The possibility exists for any evasive action taken by a driver to avoid a collision with a mammal to result in a collision with something else (e.g., another vehicle, a tree). Because these are not classified as deer-vehicle collisions, the cost associated with this type of collision is unknown. Mammals commonly involved in collisions include deer, bears, cats, coyote, dogs, foxes, opossums, raccoon, skunks, squirrels and woodchucks (Williams and Wells 2005, Smith-Patten and Patten 2008). The risk of damage increases with the size of the mammal.

Damage and Threats to Pets

Damage to property also includes attacks on cats, dogs and other pets. For example, coyotes may attack and kill cats and dogs (Grubbs and Krausman 2010, Poessel et al. 2013). Feral swine may also attack and kill domestic dogs (Mayer 2013). Attacks on pets are not limited to these examples. Pets may be attacked by a variety of species addressed in this EA.

Additionally, wildlife can transmit pathogens and parasites to pets. For example, dogs, particularly hunting dogs, may become infected with pseuorabies after coming into contact with infected feral swine. Once a dog is infected, there is no treatment, and death typically occurs soon after symptoms appear (Cramer et al. 2011). Diseases and parasites that affect pets are many of the same diseases that can infect livestock (***Damage and Threats to Livestock***, *Disease*) and humans (***Threat of Disease Transmission***). Pets that are allowed to roam for extended periods of time are at particular risk, risking exposure to a wide-range of diseases.

Damage to Infrastructure and Other Property

Mammals can cause damage to many different types of infrastructure and property. Beavers, muskrats and woodchucks dig burrows or networks of burrows, which can weaken or cause damage to foundations, roads, railways, dams, dikes, levees, storm water retention ponds and bridges (Woodward 1984, Bollengier 1994, Miller 1994, Miller and Yarrow 1994). Additionally, beavers cause damage to infrastructure when they plug culverts that allow water to pass beneath a roadway or when they impound water which washes out, undermines or floods roads, railroad beds, homes or other property.

Other damage to infrastructure occurs when animals gain entry to buildings by chewing or gnawing holes, ripping of siding or vents or simply by slipping in through small holes (Greenhall and Franz 1994, Jackson 1994*a*, Jackson 1994*b*, Timm 1994*a*, Timm and Howard 1994, Baldwin 2014). Once access to buildings is achieved these animals can shred or displace insulation, chew wiring or deposit large amounts of urine and feces which can be absorbed into building materials (Greenhall and Frantz 1994, Baldwin 2014). Items in interior spaces can also be damaged when animals consume them, shred them for nesting material (e.g., upholstered furniture) or contaminate them with urine or feces.

Many wildlife species have the ability to cause substantial damage to turf, landscaping plants and backyard gardens. Damage occurs when they consume plants or plant parts or when they root, dig, borrow, trample or wallow in parks, golf courses, residential areas or similar locations. For example, the rooting behavior that feral swine use to forage can have detrimental effects on golf courses and other recreational areas because of their ability to cause large scale damage in a short period of time.

1.3 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) AND WS DECISION-MAKING:

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.

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 most mammals is the responsibility of the Delaware Department of Natural Resources and Environmental Control (DNREC). Therefore, the lethal removal of mammals by WS to alleviate damage or reduce threats of damage as

described in this EA could only occur within the parameters established by the DNREC. Cooperation between DNREC and WS ensures WS' actions are incorporated into population objectives established by the DNREC.

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

How can WS best respond to the need to address damage caused by mammals in Delaware?

Do the alternatives have significant impacts meriting an Environmental Impact Statement (EIS)?

1.5 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

Affected Environment

Mammals can be found across the State throughout the year. Therefore, damage or threats of damage associated with mammals could occur wherever mammals 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, Cooperative Service Agreement (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, State, tribal, and municipal lands in Delaware to reduce damage and threats associated with mammals. 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 mammal damage management and addresses activities in Delaware that are currently being conducted under a MOU, CSA, or other comparable document with WS. This EA also addresses the potential impacts of mammal damage management in the State where additional agreements may be signed in the future.

Federal, State, 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 when a request was received for such services by the appropriate resource owner or manager. Actions taken on federal lands have been analyzed in the scope of this EA.

Native American Lands

The WS program would only conduct damage management activities on Native American lands when requested by a Native American Tribe. Activities would only be conducted after a MOU or CSA 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 associated with mammals on federal, State, county, municipal, and private properties under the alternatives analyzed in this EA would be available for use to alleviate damage on Tribal properties when the 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.

Site Specificity

This EA analyzes the potential impacts of alternative approaches to managing damage and threats associated with mammals that could be conducted on private and public lands in Delaware 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.

Mammals can be found across the State throughout the year. Therefore, damage or threats of damage associated with mammals could occur wherever these animals occur. Planning for the management of damage and threats associated with mammals 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 associated with mammals 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 associated with mammals in Delaware. The standard WS Decision Model (Slate et al. 1992) would be the site-specific procedure for individual actions conducted by WS (see Chapter 2 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 2 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 Delaware. 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 associated with mammals.

1.6 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 associated with mammals. The EPA is also responsible for administering and enforcing Section 404 of the Clean Water Act (CWA) along with the U.S. Army Corps of Engineers.

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.

United States Drug Enforcement Administration (DEA):

The U.S. Drug Enforcement Administration (DEA) is responsible for enforcing the Controlled Substance Act (1970). The DEA prevents the abuse and illegal use of controlled substances by regulating their production, distribution and storage.

United States Army Corps of Engineers (USACE):

The U.S. Army Corps of Engineers (USACE) is responsible for regulating all waters of the U.S. under the Clean Water Act (CWA).

Delaware Department of Natural Resources and Envrionmental Control:

The DNREC, under the direction of the Wildlife Advisory Commission, is specifically charged by the General Assembly with the management of the state's wildlife resources. The primary statutory authorities include the protection, reproduction, care, management, survival, and regulation of wild animal populations regardless of whether the wild animals are present on public or private property in Delaware.

1.7 DOCUMENTS RELATED TO THIS EA

WS' Environmental Assessments Re-Evaluated Under this EA:

WS has previously developed an EA that identified the need to manage damage associated with white-tailed deer (USDA 2006). That EA identified the issues associated with managing damage in the State and analyzed alternative approaches to meet the specific need identified in that 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 associated with white-tailed deer as well as severl other mammals, the previous EA will be superseded by this analysis and the outcome of the decision issued based on the analyses in this EA.

WS' Environmental Assessment – Oral Vaccination to Control Specific Rabies Virus Variants in Raccoons, Gray Fox, and Coyotes in the United States:

WS previously prepared an EA that identified the need to fund and participate in oral rabies vaccine (ORV) programs to eliminate or stop the spread of raccoon rabies in a number of eastern states (including Delaware) and gray fox and coyote rabies in Texas (USDA 2010). This EA identified the issues associated with funding and participating in the ORV and analyzed alternative approaches to meet the specific need identified while addressing the identified issues.

WS' Final Environmental Impact Statement – Feral Swine Damage Management:

APHIS and cooperating agencies previously prepared an EIS that addressed feral swine damage management in the United States, American Samoa, Mariana Islands, United States Virgin Islands, Guam, and Puerto Rico (USDA 2015*c*). The Record of Decision selected the preferred alternative in the EIS to implement a nationally coordinated program that integrates methods to address feral swine damage. In accordance with the Record of Decision, WS developed this EA to be consistent with the EIS and the Record of Decision.

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

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 take 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).

1.8 PUBLIC INVOLVEMENT

Issues related to the management of damage and threats associated with mammals 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.

1.9 RATIONALE FOR PREPARING AN *EA* RATHER THAN AN *EIS*

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 wild mammals are regulated by the DNREC, 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.

1.10 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.

When a non-federal entity (e.g., agricultural producers, individuals, or any other non-federal entity) takes an action involving mammals, 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 mammals 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. 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.

[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.

1.11 LAWS AND STATUTES RELATED TO THIS EA

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

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 USFWS to issue permits for the take of bald eagles and golden eagles on a limited basis (see 74 FR 46836-46837, 50 CFR 22.26, 50 CFR 22.27). 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.

Federal Food, Drug, and Cosmetic Act (21 USC 360):

This law places administration of pharmaceutical drugs, including those immobilizing drugs used for wildlife capture and handling, under the Food and Drug Administration (FDA).

Controlled Substances Act of 1970 (21 USC 821 et seq.):

This law requires an individual or agency to have a special registration number from the United States Drug Enforcement Administration (DEA) to possess controlled substances, including controlled substances used for wildlife capture and handling.

Animal Medicinal Drug Use Clarification Act of 1994 (AMDUCA):

The Animal Medicinal Drug Use Clarification Act (AMDUCA) and its implementing regulations (21 CFR 530) establish several requirements for the use of animal drugs, including those animal drugs used to capture and handle wildlife in damage management programs. Those requirements are: (1) a valid

"*veterinarian-client-patient*" relationship, (2) well defined record keeping, (3) a withdrawal period for animals that have been administered drugs, and (4) identification of animals. A veterinarian, either on staff or on an advisory basis, would be involved in the oversight of the use of animal capture and handling drugs under any alternative where WS could use those immobilizing and euthanasia drugs. Veterinary authorities in each state have the discretion under this law to establish withdrawal times (i.e., a period after a drug was administered that must lapse before an animal may be used for food) for specific drugs. Animals that people might consume within the withdrawal period must be identifiable (e.g., use of ear tags) and labeled with appropriate warnings.

Fish and Wildlife Act of 1956 (Section 16 USC 742j-l), Airborne Hunting:

This Act, passed in 1971 (Public Law 92-159), and amended in 1972 (Public Law 92-502) was added to the Fish and Wildlife Act of 1956 as a new section (16 USC 742j-l) and commonly referred to as the Airborne Hunting Act. It prohibits shooting or attempting to shoot, harassing, capturing or killing any bird, fish, or other animal from aircraft except for certain specified reasons. Under exception [see 16 USC 742j-l, (b)(1)], state and federal agencies are allowed to protect or aid in the protection of land, water, wildlife, livestock, domesticated animals, human life, or crops using aircraft.

Clean Water Act (Section 401):

As required by Section 401 of the CWA (see 33 USC 1341), an applicant for a permit issued pursuant to Section 404 of the CWA must also possess a permit from the state in which the discharge originates or will originate, when applicable. The Department of Natural Resources and Environmental Control is responsible for reviewing Water Quality Certifications applications required by Section 401 of the Clean Water Act.

Clean Water Act (Section 404):

Section 404 (see 33 USC 1344) of the CWA prohibits the discharge of dredged or fill material into waters of the United States without a permit from the United States Army Corps of Engineers unless the specific activity is exempted in 33 CFR 323 or covered by a nationwide permit by 33 CFR 330.

Food Security Act:

The Wetland Conservation provision (Swampbuster) of the 1985 (16 USC 3801-3862), 1990 (as amended by Public Law 101-624), and 1996 (as amended by Public Law 104-127) farm bills require all agricultural producers to protect wetlands on the farms they own. Wetlands converted to farmland prior to December 23, 1985 are not subject to wetland compliance provisions even if wetland conditions return because of lack of maintenance or management. If prior converted cropland is not planted to an agricultural commodity (crops, native and improved pastures, rangeland, tree farms, and livestock production) for more than five consecutive years and wetland characteristics return, the cropland is considered abandoned and then becomes a wetland subject to regulations under Swampbuster and Section 404 of the CWA.

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.

Flood Plain Management – Executive Order 11988:

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse effects associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "*each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities*".

Protection of Wetlands – Executive Order 11990:

Executive Order 11990 was signed to "*minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands*". To meet those objectives, Executive Order 11990 requires federal agencies to consider alternatives to wetland sites, in planning their actions, and to limit potential damage, if a federal agency cannot avoid an activity affecting a wetland.

CHAPTER 2: ISSUES AND ALTERNATIVES

This chapter contains a discussion of the issues which were used to develop alternatives to address the need for action. It also contains a discussion of Integrated Wildlife Damage Management (IWDM) as well as a description of WS' strategies, decision making process and standard operating procedures (SOPs). Finally, this chapter presents alternatives developed to address the issues and meet the need for action. It also presents alternatives considered but not analyzed in detail, with rationale.

2.1 ISSUES USED TO DEVELOP 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 mammals in Delaware were developed by WS through discussions with partnering agencies, cooperators, and stakeholders.

The issues as they relate to the possible implementation of the alternatives, including the proposed action alternative, are discussed in Chapter 3. The issues analyzed in detail are the following:

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

A common issue when addressing damage caused by animals 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 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 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 for the magnitude of impact on the populations of target animals is based on a measure of the number of individuals from each species removed in relation to that species' abundance and/or status (e.g., nuisance species, game species, etc.). 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 or status. Lethal removal would be monitored by comparing the number of animals lethally removed with overall populations or trends. Lethal methods would only be used by WS at the request of those persons seeking assistance. In many damage situations, lethal removal of wild mammals addressed in this document could occur at any time with approval from the DNREC, 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 habitat.

Information on wild mammal populations and trends are derived from several sources including state harvest data and surveys. Additional information on those sources of information is provided below.

Annual Hunter Harvest Estimates

Hunting seasons are established and enforced by the DNREC. The DNREC conducts periodic hunter mail surveys of all potential hunters to estimate harvest/effort/participation in hunting. Although the lethal removal of some wild mammals addressed in this document can occur throughout the year when they are causing damage without need for a license, many are lethally removed by individuals with licenses, and therefore reported during the survey.

Actual Hunter and Trapper Harvest Figures

The DNREC establishes and enforces both hunting and trapping seasons and requires that all white-tailed deer harvested are reported to the DNREC. Therefore, the actual number and not an estimate of white-tailed deer harvested on an annual basis is known. All harvested coyotes are supposed to be reported to DNREC, but there is not an accurate compliance rate.

Annual Trapper Harvest Estimates

The DNREC performs periodic trapper mail surveys of all licensed trappers or license-exempt individuals who indicated they would be trapping.

Issue 2 - 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 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 3 of this EA will discusses the potential for WS' activities to disturb eagles as defined by the Act.

Issue 3 - 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 mammals. 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, to persons coming into contact with methods or persons harvesting and then consuming animals which have been previously immobilized with drugs. 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 be employed or recommended including, euthanasia chemicals, immobilization drugs, repellants, fumigants (chemical gases that are used to lethally remove animals in dens or burrows), predacides (chemicals used to lethally remove predators) and rodenticides (chemicals used to lethally remove rodents). All of these chemical methods except for predacides would be available under all of the alternatives analyzed in detail.

The use of chemical methods is strictly regulated. Restricted use chemicals can only be applied by persons who have been specially trained and certified for their use. These persons (certified applicators) are required to take continuing education credits and exams to maintain their certification. All of the chemical methods listed above, including methods available for use to the public, have specific requirements for their handling, transport, storage, use and disposal. 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 mammals 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 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 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. All of the non-chemical methods available to address damage would be available for use by any entity, when permitted, under all of the alternatives analyzed in detail.

Issue 4 – 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 3. SOPs to alleviate pain and suffering are discussed later in this chapter.

2.2 DAMAGE MANAGEMENT STRATEGIES

Integrated Wildlife Damage Management (IWDM)

The most effective approach to resolving wildlife damage is to use an adaptive integrated approach that may call for the use of several methods simultaneously or sequentially. The philosophy behind IWDM 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. IWDM may incorporate cultural practices (e.g., animal husbandry), habitat modification (e.g., exclusion), animal behavior modification (e.g., scaring), removal of individual offending animals, local population reduction, elimination of invasive species (e.g., feral swine) or any combination of these, depending on the circumstances of the specific damage problem.

The IWDM Strategies Employed by WS

Direct Operational Assistance
Direct operational assistance includes damage management activities that are directly conducted or supervised by WS personnel. Direct operational assistance may be initiated when the problem cannot effectively be resolved through technical assistance alone and when a Memorandum of Understanding, Cooperative Service Agreement, or other comparable document provide for direct damage management by WS. The initial investigation defines the nature, history, and extent of the problem, species responsible for the damage, and methods available to resolve the problem.

Technical Assistance Recommendations
"Technical assistance" is the provision of information, demonstrations, and advice on available and appropriate wildlife damage management methods and approaches. The implementation of damage management actions is the responsibility of the requester with no direct involvement by WS. In some cases, WS provides supplies or materials that are not readily available. Technical assistance may be provided through a personal or telephone consultation, or during an on-site visit with the requester. Generally, several management strategies are described to the requester 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, wildlife-related provided to the requestor by WS results in tolerance and / or acceptance of the situation. In other instances, management options are discussed and recommended.

WS technical assistance is categorically excluded from the need to prepare an EA or EIS under APHIS implementing regulations and guidance. However, it is discussed in this EA because it is an important component of the IWDM approach to resolving mammal damage problems.

Education
An important component of technical assistance is education. Education is important because wildlife damage management is about finding compromise between the needs of people and needs of wildlife, and coexistence between them. 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, state 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.

Wildlife Services Decision Making

WS personnel use a thought process for evaluating and responding to damage complaints which is depicted by the WS Decision Model and described by Slate et al. (1992) (Figure 2.0). WS personnel are frequently contacted after requesters have tried or considered non-lethal methods and found them to be impractical, too costly, or inadequate to reduce damage. WS personnel assess the problem and evaluate the appropriateness and availability (legal and administrative) of strategies and methods based on biological, economic and social factors. Methods deemed practical for the situation are then developed into a management strategy. WS would continue to monitor and evaluate the situation as assistance (either technical or direct) is provided, modifying the strategy and methods used to reduce the damage to an acceptable level. In terms of the WS Decision Model (Slate et al. 1992), most damage management efforts consist of continuous feedback between receiving the request and monitoring the results of the damage management strategy. The Decision Model is not a written documented process, but a mental problem-solving process common to most, if not all, professions.

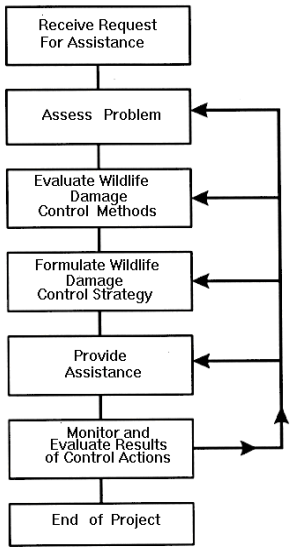

Figure 2.0 WS Decision Model as presented by Slate et al. (1992) for developing a strategy to respond to a request for assistance with human-wildlife conflicts.

Community-based Decision Making

The WS program follows the "co-managerial approach" to solve wildlife damage or conflicts as described by Decker and Chase (1997). Within this management model, WS could provide technical assistance regarding the biology and ecology of mammals and effective, practical, and reasonable methods available to the local decision-maker(s) to reduce damage or threats. This could include non-lethal and lethal methods depending on the alternative selected. WS and other state, tribal and federal wildlife management agencies may facilitate discussions at local community meetings when resources are available.

Requests for assistance to manage damage caused by mammals often originate from the decision-maker(s) based on community feedback or from concerns about damage or threats to human safety. As representatives of the community, the decision-maker(s) are able to provide the information to local interests either through technical assistance provided by WS or through demonstrations and presentation by WS on mammal damage management activities. This process allows decisions on mammal damage management activities to be made based on local input. They may implement management recommendations provided by WS or others on their own, or may request management assistance from WS, other wildlife management agencies, local animal control agencies, or private businesses or organizations.

2.3 STANDARD OPERATING PROCEDURES FOR MAMMAL 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 associated with mammals.

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 EPA and the Delaware Department of Agriculture (DDA), 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 (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.

- 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.

- All euthanasia and immobilization drugs used by WS or recommended by WS would be registered with the FDA, and stored and used in compliance with DEA regulations as required.

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

- 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.

- 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, state, and local laws and regulations in accordance with WS Directive 2.210.

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

2.4 ADDITIONAL STANDARD OPERATING PROCEDURES SPECIFIC TO THE ISSUES

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

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

- Lethal removal of wild mammals by WS would be monitored by the DNREC to ensure cumulative lethal removal is considered as part of population management objectives.

- WS would monitor wild mammal damage management activities to ensure activities do not adversely affect their populations in the State.

- 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.

Issue 2 - Effects of Damage Management Activities on Non-target Animals, Including Threatened and Endangered Species

- 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.

- 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.

- WS would review the current federal threatened and endangered species list for Delaware each year to determine if new species have been added and will evaluate potential impacts to those species from mammal damage management activities.

Issue 3 - 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 or recommended by WS would be registered with the EPA, DEA, FDA and/ or the DNREC, as appropriate.

- 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.

- Controlled chemical immobilization and euthanizing agents will be used by WS in compliance with applicable state and federal laws and regulations to reduce risks to human health and safety (WS Directive 2.430).

- WS would adhere to all established withdrawal times for mammals when using immobilizing drugs for the capture of mammals that were agreed upon by WS, the DNREC, and veterinarian authorities. If WS receives a request to immobilize mammals during a period of time when the regulated harvest of those species was occurring or during period of time where the withdrawal

period could overlap with a harvest season, WS would euthanize the animal or mark the animal with ear tags labeled with a "*do not eat*" warning.

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

Issue 4 – Humaneness and Animal Welfare Concerns

- WS personnel would be trained in the latest and most humane devices and methods for removing mammals.

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

- WS' use of immobilization and euthanasia methods would comply with WS Directive 2.505 and WS Directive 2.430.

- 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.

2.5 ALTERNATIVES CONSIDERED IN DETAIL

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 3. Chapter 2 also discusses alternatives considered but not analyzed in detail, with rationale.

The following alternatives were developed to address the identified issues associated with managing damage and threats associated with mammals:

Alternative 1 – WS Would Continue to Address Mammal Damage 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 associated with mammals. Under this alternative, WS could respond to requests for assistance for managing damage and threats associated with mammals 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) providing technical assistance and direct operational assistance to a property owner or manager experiencing damage or threats of damage. Direct operational assistance could be provided when funding is available through federal appropriations or cooperative funding. WS response to requests for assistance is dependent upon on those persons initiating the request. Those persons receiving technical assistance could 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 hunters), 5) use the services of local law enforcement or animal control authorities (in the case of dogs or cats) 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.

The most effective approach to resolving any animal damage problem is to use an adaptive integrated approach (IWDM) that may call for the use of several methods simultaneously or sequentially. This approach is used by WS for providing both technical and direct operational assistance. WS personnel use a thought process for evaluating and responding to requests for assistance detailed in the WS Decision Model (See ***Wildlife Services Decision Making***). IWDM 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. 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 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 mammals from the area resulting in a reduction in the presence of those mammals at the site.

Lethal methods remove individuals of the species causing the damage, thereby reducing the presence of those species in the area and the local population. Lethal methods are often employed or recommended to reinforce non-lethal methods and to remove mammals that have been identified as causing damage or posing a threat of damage as part of an integrated approach. The number of mammals removed from the population using lethal methods under the proposed action would be dependent on the number of requests for assistance received, the number of mammals involved with the associated damage or threat, and the efficacy of methods employed. WS may recommend mammals be harvested during regulated hunting and/or trapping seasons or lethally removed under nuisance wildlife regulations in an attempt to reduce the number of mammals causing damage. Appendix B contains a thorough discussion of the methods available for use in managing damage and threats associated with mammals 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.

The WS program follows the "*co-managerial approach*" to solve wildlife damage or conflicts as described by Decker and Chase (1997). Within this management model, when numerous people are being affected by damage or threats associated with mammals, and a request for assistance is made, WS advocates providing technical assistance to the local decision-maker(s). Requests for assistance often originate from community representatives who have been notified by community members concerned about damage and threats associated with mammals. By involving decision-maker(s) in the process, damage management actions can be presented to allow decisions on damage management to involve those individuals that the decision maker(s) represent. Local decision-maker(s) could be elected officials or appointees who oversee the interests and business of the local community. Local decision-maker(s) could represent the local community's interest and make decisions for the community or they could relay technical assistance information to a higher authority or the community for discussion and decision-making. Local decision-maker(s) could also request that WS present technical assistance information at public meetings to allow for involvement of the community. Involving the appropriate representatives of the community ensures a community-based decision is made. In the case of private property, the decision-maker is the individual that owns or manages the affected property. The decision-maker has the discretion to involve others as to what occurs or does not occur on property they own or manage.

Alternative 2 – WS Would Address Mammal Damage Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats associated with mammals 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 associated with mammals. 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 could take action using those methods legally available to resolve or prevent damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Alternative 3 – WS Would Not Address Mammal Damage

Under this alternative, WS would not conduct technical or direct operational assistance to reduce threats or alleviate damage associated with mammals. WS would not be involved with any aspect of managing damage associated with mammals. All requests for assistance received by WS to resolve damage caused by mammals would be referred to the DNREC, local law enforcement or animal control authorities and/or private entities. This alternative would not prevent other federal, state, and/or local agencies, including private entities from conducting damage management activities directed at alleviating damage and threats associated with mammals. Similar to Alternative 2, 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 could take action using those methods legally available to resolve or prevent damage associated with mammals as permitted by federal, state, and local laws and regulations or those persons could take no action.

2.6 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 associated with mammals. 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 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 associated with mammals 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 DNREC 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 associated with mammals under this alternative. Similar to Alternative 2 and 3, all lethal methods listed in the Appendix would be available under this alternative.

Under this alternative, resource 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, resource 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 mammals could continue at the levels analyzed in Alternative 1, despite the lack of WS' involvement.

WS Would Use Lethal Methods Only

Under this alternative, the only methods available for recommendation and use in resolving damage or threats associated with mammals 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 Only Trap and Translocate Mammals

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). Wild mammals are managed by the DNREC and translocation of them could only occur under the authority of the DNREC.

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). Many animals show strong homing behavior (Bradley et al. 2005) and may return to the site after being relocated. 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. 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 Regulated Hunting and Trapping to Manage Damage Associated With Mammals

Under this alternative, all requests for assistance received by WS would be addressed by recommending the use of regulated hunting and trapping to reduce populations of those wild mammals causing damage. The DNREC is responsible for establishing and enforcing hunting and trapping seasons in the State. Recreational hunting and trapping by private individuals when based on biological information and properly regulated can be effectively used to manage wildlife populations. However, regulated hunting and trapping is often not allowed in all locations where damage occurs (e.g., airports or near houses and buildings where the use of firearms and traps are restricted or in some cases prohibited), during times of year when damage occurs (e.g., when agricultural crops are most vulnerable), or may not remove enough animals to reduce the damage (e.g., because of method restrictions).

For example, in urban and suburban areas where hunting white-tailed deer with firearms is not allowed, archery hunting may provide an alternative method for managing populations. Under these circumstances, archery hunting may be used as an effective management tool to reduce urban deer populations (Kilpatrick and Walter 1999). However, in many circumstances it may be difficult to remove a sufficient number of deer using archery hunting alone to reduce the population to a level that sufficiently reduces damage caused by deer (Williams et al. 2013, Weckel and Rockwell 2013). For example, Ver Stegg et al. (1995) found that it was not possible for archery hunting alone to reduce a deer population in a suburban park in Illinois to meet reduction goals.

In similar situations in New Jersey and Pennsylvania, Williams et al. (2013) found that despite extended hunting seasons (5 months), the use of bait, and no harvest limits, hunting was unable to reduce deer densities to a level that would reduce damage. Hunting in these scenarios is limited in its potential to reduce population levels because: 1) some landowners are unwilling to let hunters on their property, 2) some hunters may desire greater densities for hunting, 3) landowners and hunters may not comprehend the number of deer that must be removed to meet goals, and 4) hunters do not always take precautions to avoid educating deer (i.e., altering deer behavior so that they are less susceptible to hunters) (Williams et al. 2013). Additionally, as deer are harvested the amount of effort to remove additional deer must increase (Weckel and Rockwell 2013) and may be undermined as the number of hunters willing to participate, the number of hunting trips and the length of hunts declines (Wiggers 2011, Weckel and Rockwell 2013).

The hunting and trapping of wild mammals can only occur at the discretion of the DNREC, which ensures that removal occurs to achieve desired population objectives for each species. Therefore, regulated hunting and trapping could continue to occur under any of the alternatives analyzed in detail at the discretion of the DNREC. Under Alternative 1 (the proposed action alternative) and Alternative 2, WS could recommend, when appropriate, that hunting and/or trapping be used by the resource owner or manager on property they own or manage where damages were occurring. However, allowing hunting and/or trapping would be the decision of the owner or manager of the property. Since WS does not have the ability to require hunting and/or trapping to resolve damage, this alternative was not analyzed in detail.

WS Would Use Reproductive Control to Reduce Populations of Wild Mammals in the State that are Causing Damage

Under this alternative, the only method available by WS for recommendation or use in resolving damage or threats associated with wild mammals would be reproductive control. Reproductive control for wildlife can be accomplished either through sterilization (permanent) or contraception (reversible). 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.), the nature of the local environment (e.g., isolation of target population, access to target individuals, etc.), and other biological factors. In general, if the time needed to reduce damage is a factor in selecting a management method, lethal control will always be more efficient than reproductive control because reproductive control cannot generate a more rapid population decline (Bradford and Hobbs 2008, McLeod and Sanders 2014).

Currently, the only reproductive inhibitor that is registered with the EPA for use in any of the species addressed in this document is GonaCon™. GonaCon™ was officially registered by the EPA in 2009 for use in reducing fertility in female white-tailed deer. However, GonaCon™ is not currently registered for use in Delaware.

WS Would Provide Financial Compensation for Damage Associated with Mammals

Under this alternative, WS would provide financial compensation to those persons requesting assistance who were experiencing damage associated with mammals. 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).

The management of wild mammals is the responsibility of the DNREC. Currently, no compensation program exists for offsetting damage addressed in the need for action. WS does not have the legal authority to provide financial compensation for damage; 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 associated with mammals. Providing financial compensation to those persons experiencing damage would be ineffective at meeting the need for action because it does not reduce damage and threats. Because providing financial compensation would fail to meet the need for action, this alternative was not considered further.

CHAPTER 3: ENVIRONMENTAL EFFECTS

This chapter provides the information needed for making an informed selection among the alternatives identified and described in Chapter 2; 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/or 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 occur later in time or further 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.

3.1 ISSUES CONSIDERED IN DETAIL AND THEIR ASSOCIATED ENVIRONMENTAL CONSEQUENCES BY ALTERNATIVE

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 Delaware state agencies.

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

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

Alternative 1 – WS Would Continue to Address Damage 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 associated with mammals as described in chapter 2. 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. When effective, non-lethal methods would disperse mammals 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 mammals would be monitored by comparing the number of each species lethally removed with that species' overall population trend (when available) and / or the magnitude of lethal removal in comparison to other known lethal take occurring (when available) to assure the magnitude of lethal removal is maintained below the level that would cause adverse effects to the viability of species' populations. The potential impacts on mammal populations from the implementation of the proposed action / no action alternative are analyzed for each species below.

Virginia Opossum Population Impact Analysis

Opossums are distributed throughout the eastern U.S. (Seidenstriker et al. 1987, Linzey 1998, Gardner and Sunquist 2003). They prefer deciduous woodlands with access to water but can be found almost anywhere in their range including areas of dense human habitation (Seidenstriker et al. 1987, Gardner and Sunquist 2003). Opossums are solitary animals (Gardner and Sunquist 2003). Females produce 1–2 litters each year of 1–15 young (Gardner and Sunquist 2003). Opossums are not territorial; their average home range varies depending on habitat and sex (2.4–350.8 acres) (Gardner and Sunquist 2003). The population density of opossums in prime habitat in Virginia has been estimated at 10.1 opossums per square mile with a range of 1.3–20.2 per square mile (Seidenstriker et al. 1987).

The number of opossums lethally removed by WS to alleviate damage and threats as well as the number harvested by trappers and hunters in Delaware from 2012 to 2016 is shown in Table 3.1. Although lethal removal of opossums can occur throughout the year, many are lethally removed during hunting and trapping season. From 2012 to 2016, the average annual number of opossum harvested was 408 according the DNREC hunter and trapper mail surveys. The total number of opossums lethally removed by other entities to alleviate damage or nuisance issues is unknown.

Table 3.1: The number of Virginia opossums removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	507
2013	0	639
2014	0	365
2015	0	311
2016	0	219
AVERAGE	**0**	**408**

Direct, Indirect, and Cumulative Effects:
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 50 opossums annually under the proposed action alternative to manage damage or threats of damage.

The lethal removal of up to 50 opossums would represent 12.25% (408) of the total known average annual hunter and trapper harvest from 2012 – 2016. The analysis will derive a population estimate based on the best available information to provide an indication of the magnitude of opossum removal proposed by WS to alleviate damage and threats of damage. Opossums are primarily associated with deciduous woodlands near streams, marshlands, forests, grasslands, agricultural habitats, agricultural edges (Seidensticker et al. 1987). According to the Forest Service, Delaware has a total of 380,000 acres of forestland (Delaware Forest Service 2017). If opossums only occurred on 50% of the forestland (190,000) at the mean density of 10.1 opossum per square mile (Seidensticker et al. 1987), the population would be approximately 3,000 opossums. The lethal annual removal of 50 opossums by WS would represent less than 2% of the conservative estimate of 3,000 opossums occupying 50% of the Delaware forestland.

Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the estimated population of opossum in the state, WS' proposed lethal removal should not have any significant direct or cumulative impact on opossum populations. WS' lethal removal would be a limited component of the overall harvest and could be considered of low magnitude when compared to the number of opossums being harvested and lethally removed in Delaware. Harvest and lethal removal of opossums can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of opossums lethally removed annually to the DNREC.

Eastern Cottontail Population Impact Analysis

Eastern cottontails are widely distributed across much of the U.S. (Linzey 1998, Chapman and Litvaitis 2003). Preferred habitats include abandoned agricultural fields, areas with a dense shrub understory, pastures, swamps, marshes and suburban areas (DeGraaf and Yamasaki 2001, Chapman and Litvaitis 2003). Females produce 3–4 litters each year of 3–6 young, on average (DeGraaf and Yamasaki 2001, Chapman and Litvaitis 2003). Eastern cottontails are not territorial, and their average home range varies depending on season and sex (0.5–40.0 acres) (DeGraaf and Yamasaki 2001, Chapman and Litvaitis 2003). The population density of eastern cottontails has been estimated as 0.46 rabbits per acre to 8.09 rabbits per acre (DeGraaf and Yamasaki 2001, Chapman and Litvaitis 2003).

The number of eastern cottontails lethally removed by WS to alleviate damage and threats as well as the number harvested by hunters from 2012 to 2016 is shown in Table 3.2. Eastern cottontail harvest is reported during an annual hunter mail survey conducted by the DNREC. The average annual hunter harvest from 2012 to 2016 was 9,498 eastern cottontails per year, with a high of 13,429 that was reported in 2012. The total number of eastern cottontails lethally removed by individuals to alleviate damage is unknown.

Table 3.2: The number of eastern cottontails removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	13,429
2013	0	13,372
2014	0	8,297
2015	0	7,481
2016	0	4,909
AVERAGE	**0**	**9,498**

Direct, Indirect, and Cumulative Effects:
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 25 eastern cottontails annually under the proposed action alternative to manage damage or threats of damage. The lethal removal of up to 25 eastern cottontails would represent 0.26% of the average number harvested annually by hunters (9,498) between 2012-2016. Given the limited lethal removal proposed by WS when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on eastern cottontail populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal occurring within Delaware and could be considered of low magnitude when compared to the number of eastern cottontails being harvested. Harvest and lethal removal of eastern cottontails can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of eastern cottontails lethally removed annually to the DNREC.

Woodchuck Population Impact Analysis

Woodchucks, also known as groundhogs, can be observed from eastern Alaska through southern Canada to the Atlantic and south to Georgia and Alabama and west to Kansas and Nebraska (Armitage 2003). Habitat includes open woodlands, pastures, meadows, cultivated fields, road rights-of-way, utility corridors and other human dominated landscapes (DeGraaf and Yamasaki 2001, Armitage 2003). Woodchucks are not social but can live at high densities in close proximity to one another (DeGraaf and Yamasaki 2001, Armitage 2003). The population density of woodchucks has been estimated as ranging from one woodchuck per 2.7 acres to one woodchuck per 20 acres (DeGraaf and Yamasaki 2001) although much higher densities (i.e., 11 per acre or more) have been reported (Twitchell 1939). The average home range is dependent on sex and the availability of food resources, ranging between five and 137 acres (DeGraaf and Yamasaki 2001). Woodchucks have one litter per year of two to six with a mean of approximately five young (DeGraaf and Yamasaki 2001, Armitage 2003). The woodchuck population is unknown.

The number of woodchucks lethally removed by WS as well as the number harvested by hunters from 2012 to 2016 is shown in Table 3.3. Although lethal removal of woodchucks can occur throughout the year, many are lethally removed during hunting seasons, and therefore reported during an annual hunter harvest survey conducted by the DNREC. The average annual hunter harvest from 2012 to 2016 was

5,037 woodchucks per year. The total number of woodchucks lethally removed by individuals to alleviate damage or nuisance issues in the State is unknown.

Table 3.3: The number of woodchucks removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	5,249
2013	0	6,901
2014	0	4,324
2015	3	3,801
2016	4	4,909
AVERAGE	**1.4**	**5,037**

Direct, Indirect, and Cumulative Effects:
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 200 woodchucks annually under the proposed action alternative to manage damage or threats of damage. The lethal removal of up to 200 woodchucks would represent 4% of the average number of woodchucks harvested annually by hunters (5,037). As stated in Appendix B, WS could use large gas cartridges to fumigate woodchuck burrows where damage is occurring. The take of 200 woodchucks under the proposed action would include woodchucks killed during the fumigation of burrows. Woodchucks are solitary and burrows are rarely shared (Armitage 2003). Based on an average litter size of five young (see average litter size discussion above) and the fact that only the mother provides parental care, fumigation of an occupied burrow site would be expected to lethally remove a maximum of six individuals. Woodchuck burrows can have 1−11 entrances with three being the approximate average number (Twitchell 1939, Merriam 1971, Henderson and Gilbert 1978). Therefore, based on this information, fumigation of three woodchuck burrows could result in a maximum lethal removal of six woodchucks, or the treatment of 99 burrows could result in a maximum lethal removal of 198 woodchucks. This figure is very liberal because A) all fumigation would have to occur during spring through mid-summer when young are present (Maher 2006), B) all fumigation would involve treatment of burrows of females with young (e.g., no male burrows would be treated), and C) all fumigation would involve occupied burrows (woodchucks frequently move between burrows. Swihart (1992) found woodchucks used an average of eight burrows. Therefore, treatment of 99 burrows would likely result in a much lower level of lethal removal.

Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on woodchuck populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal occurring within Delaware and could be considered of low magnitude when compared to the number of woodchucks being harvested and lethally removed. Harvest and lethal removal of woodchucks can only occur at the discretion of the DNREC and the DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report woodchucks lethally removed annually to the DNREC.

Gray Squirrel Population Impact Analysis

Gray squirrels are distributed east of the Mississippi (Edwards et al. 2003). In general, gray squirrels prefer mature hardwood forest with a dense understory (Edwards et al. 2003). Squirrels are also present in urban and suburban areas (DeGraaf and Yamasaki 2001). Gray squirrels do not live in social groups although they use communal sites (e.g., tree cavities) for shelter (Edwards et al. 2003). Gray squirrels have 1–2 liters per year of two to three young, on average (Edwards et al. 2003). The population density of squirrels varies considerably depending on habitat (Edwards et al. 2003). Gray squirrel densities have been estimated from 47 to 3,647 squirrels per square mile (Edwards et al. 2003). Average home range sizes also vary considerably (Edwards et al. 2003) from 0.9 to 13.3 acres (Edwards et al. 2003). Territoriality is limited to females defending young (Edwards et al. 2003).

The number of gray squirrels lethally removed by WS to alleviate damage and threats as well as the number harvested by hunters from 2012 to 2016 is shown in Table 3.4. Although lethal removal of squirrels can occur throughout the year, many are lethally removed during hunting seasons, and therefore reported during an annual hunter mail survey conducted by the DNREC. The average annual hunter harvest from 2012 to 2016 was 11,311 gray squirrels per year. The total number of squirrels lethally removed by individuals without licenses to hunt other game or by other entities to alleviate damage in the State is unknown.

Table 3.4: The number of Gray squirrel removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	11,787
2013	0	13,992
2014	0	9,886
2015	0	13,209
2016	0	7,681
AVERAGE	**0**	**11,311**

Direct, Indirect, and Cumulative Effects:
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 25 gray squirrels annually under the proposed action alternative to manage damage or threats of damage. The lethal removal of up to 25 gray squirrels would represent 0.22% of the average number of gray squirrels harvested annually by hunters (11,311). Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on gray squirrel populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of squirrels being harvested and lethally removed in Delaware. Harvest and lethal removal of squirrels can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of squirrels lethally removed annually to the DNREC.

Beaver Population Impact Analysis

Beavers are distributed throughout the U.S. and Canada in suitable habitat (Baker and Hill 2003). Beavers can occupy a wide variety of habitats as long as fresh water is present (e.g., streams, rivers, ponds, lakes, bogs, marsh, reservoirs and drainage ditches) (DeGraaf and Yamasaki 2001, Baker and Hill 2003). Most beavers are members of social groups which share the same territory (Baker and Hill 2003). Groups consist of a breeding pair, the young born in the current year and young of the previous 1–2 years (Baker and Hill 2003). In the eastern U.S., a total of three to eight beavers compromise the average group (Novak 1987). The breeding pair produces a single litter each spring of 2–4 young, on average (Baker and Hill 2003). The population density of beavers has been reported as high as three groups per square mile (Alabama) (Baker and Hill 2003). The State's beaver population is unknown.

The number of beavers lethally removed by WS to alleviate damage and threats from 2012 to 2016 is shown in Table 3.5, along with those removed by hunters/trappers according to the DNREC. Although lethal removal of beavers can occur throughout the year, many are lethally removed by individuals during the trapping season. According to the DNREC's annual survey results, there was an estimated average of 212 beaver harvested between 2012 and 2016. The total number of beavers lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.5: The number of beavers removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal (MIS)	# of Animals harvested (DNREC)
2012	0	344
2013	0	247
2014	0	149
2015	0	153
2016	0	165
AVERAGE	**0**	**212**

Direct, Indirect, and Cumulative Effects:
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 100 beavers annually under the proposed action alternative to manage damage or threats of damage. Beaver densities per unit of area calculated from other studies in the United States and Canada have ranged from 0.4 beaver families per square mile to a high of 11.9 beaver families per square mile (Novak 1987). Density estimates in the United States and Canada based only on stream miles (*i.e.*, per a linear unit of measure) have ranged from 0.8 beaver colonies per stream mile to 3.9 beaver colonies per stream mile (Novak 1987). According to the DNREC (DNREC 2017), Delaware has over 226,000 acres of wetlands, including an estimated 2,500 miles of rivers and streams (DNREC 2017). To evaluate a worst-case scenario, the estimated statewide beaver population will use the lowest beaver colony density per linear measure derived from other studies of 0.8 beaver colonies per stream mile. If all of the stream and river miles in Delaware were suitable beaver habitat and if beaver

colonies occupied all of those miles, approximately 2,000 beaver colonies would occur along the 2,500 miles of river and streams in the State, which would not include beaver colonies that inhabit wetlands, lakes, ponds, and other aquatic habitats.

The number of beaver per colony is also required to derive a population estimate. In Georgia, Parrish (1960) estimated the average number of beaver per colony at 5.3 beaver, which is similar to the average of 4.6 beaver per colony in Alabama that Wilkinson (1962) estimated. From other studies, the average size of beaver colonies has ranged from 3.2 beaver to 9.2 beaver per colony (Novak 1987). Therefore, if there were 2,000 beaver colonies along the rivers and streams of the State and if there were 5.3 beaver per colony, the population inhabiting rivers and streams would be 10,600 beaver. If only 50% of the rivers and streams in the State provided suitable beaver habitat, then a beaver population could be approximately 5,300 beaver. The actual statewide population is likely much larger than 5,300 beaver because the estimate was calculated using the average density information available for beaver in the US. In addition, the population estimate did not include beaver that could inhabit other aquatic habitats or create their own habitats by impounding water in areas associated with water runoff or storage (*e.g.*, drainage ditches, irrigation canals, storm water storage).

The lethal removal of up to 100 beavers would represent 1.9% of the estimated state population of beaver. Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, along with the estimated state population, WS' proposed lethal removal should not have any significant direct or cumulative impact on beaver populations. WS' lethal removal would be a limited component of the overall harvest and could be considered of low magnitude when compared to the numbers of beavers being harvested and lethally removed. Harvest and lethal removal of beavers can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of beavers lethally removed annually to the DNREC.

Additionally, under the proposed action alternative, WS could breach, remove or install water control devices on up to 100 dams annually. The breaching or removal of beaver dams would not adversely affect beaver populations because no beavers will be lethally removed during those activities.

Muskrat Population Impact Analysis

Muskrats are distributed across much of the U.S. (Linzey 1998, Erb and Perry 2003). Muskrat habitat includes salt, fresh and brackish marshes, ponds, lakes, streams, rivers, ditches and canals (Erb and Perry 2003). Generally, muskrat social structure consists of a breeding pair and their offspring which remain until fall or spring before dispersing (Boutin and Birkenholz 1987). Muskrats are capable of breeding year round (Boutin and Birkenholz 1987). Females typically produce 2–3 litters a year of 3–10 young (Boutin and Birkenholz 1987, Erb and Perry 2003). Summer home ranges of muskrats in marshes average 135–195 feet in diameter (Erb and Perry 2003). Population density is largely dependent on habitat, season and other variables and range from 2.9 to 40 muskrats per acre (Erb and Perry 2003). The State's muskrat population is unknown.

The number of muskrats lethally removed by WS to alleviate damage and threats as well as the number harvested by trappers from 2012 to 2016 is shown in Table 3.6. Although lethal removal of muskrats can occur throughout the year, many are lethally removed during the trapping season. The DNREC conducts a trapper mail survey of licensed trappers, or license exempt persons who indicated they would be trapping to quantify the number of animals harvested during the trapping season. From 2012 to 2016, the average annual number of muskrat harvested was 15,119. The total number of muskrats lethally removed by other entities to alleviate damage or nuisance issues is unknown.

Table 3.6: The number of muskrat removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	20,183
2013	0	22,691
2014	0	15,248
2015	0	10,922
2016	0	6,550
AVERAGE	**0**	**15,119**

Direct, Indirect, and Cumulative Effects:
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 50 muskrats annually under the proposed action alternative to manage damage or threats of damage. The lethal removal of up to 50 muskrats would represent 0.33% of the average trapper harvest from 2012 - 2016 (15,119). Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on muskrat populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of muskrats being harvested and lethally removed in Delaware. Harvest and lethal removal of muskrats can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of muskrats lethally removed annually to the DNREC.

Coyote Population Impact Analysis

Originally a western plains species, coyotes began moving eastward around 1900 (Moore and Parker 1992, Parker 1995). Now, all eastern states and Canadian provinces have at least a small population of coyotes (Voigt and Berg 1987). Coyotes inhabit a wide range of habitats (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 5.4 pups (n = 9) (Albers et al. 2016). The average home range 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 (New York) to 3.88 coyotes per square mile (South Carolina) (Schrecengost 2007, Frair et al. 2014).

Delaware's coyote population is small, but they are found in all three counties, with the majority of the population occurring in New Castle County. The DNREC established its first hunting season for coyotes in 2014. Additionally, the DNREC established a depredation order in 2014 stating that coyotes can be seriously injurious to livestock, domestic animals, and human safety. The order pre-authorizes landowners or their agents to use deadly force to remove coyotes under circumstances that present an imminent threat of injury (DNREC 2018).

The number of coyotes lethally removed by WS as well as the number harvested by hunters and trappers from 2012 to 2016 is shown in Table 3.7. The DNREC performs annual hunter and trapper mail surveys to estimate harvest. The average annual hunter harvest from 2012 to 2016 was 24 coyotes per year. The total number of coyotes lethally removed by individuals without hunting licenses or by other entities to alleviate damage or nuisance issues is unknown.

Table 3.7: The number of coyote removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	31
2013	0	70
2014	0	0
2015	0	0
2016	0	21
AVERAGE	**0**	**24**

Direct, Indirect, and Cumulative Effects:
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 six coyotes annually under the proposed action / no action alternative to meet the need for action as described in this EA. The lethal removal of up to six coyotes would represent 25% of the average number of coyotes harvested annually by hunters and trappers. This level of removal is insignificant given the coyotes' reproductive ability and Delaware's established depredation order.

WS could use large gas cartridges to fumigate coyote dens where damage 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 six, fumigation of a single coyote den would result in the lethal removal of approximately six pups. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of coyotes estimated to be in the state. Harvest and lethal removal of coyotes can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of coyotes lethally removed annually to the DNREC.

Red Fox Population Impact Analysis

Although native to North America, red foxes were largely absent from the mid-Atlantic and southeastern U.S. at the time of European settlement (Linzey 1998, Statham et al. 2012, Frey 2013). Red foxes can now be found in the state of Delaware due to range expansion southward allowed by habitat alteration (Rogerson 2011). 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). 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 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).

The number of red foxes lethally removed by WS as well as the number harvested by hunters and trappers from 2012 to 2016 is shown in Table 3.8. Lethal removal of red foxes can occur throughout the year, but many are removed during hunting and trapping seasons. Red foxes harvested are reported during an annual hunter mail survey and trapper mail survey conducted by the DNREC. The average annual harvest from 2012 to 2016 was 4,410 red foxes per year. The total number of red foxes lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.8: The number of red fox removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	3,949
2013	0	5,293
2014	0	4,378
2015	3	3,704
2016	20	4,725
AVERAGE	**4.6**	**4,410**

Direct, Indirect, and Cumulative Effects:
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 200 red foxes annually under the proposed action alternative to meet the need for action as described in this EA. The lethal removal of up to 200 red foxes would represent 4.5% of the average number of red foxes harvested annually by (4,410). WS could use large gas cartridges to fumigate red fox dens where damage 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 five 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 six individuals. Given the limited lethal removal proposed by WS to alleviate damage and threats 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 and could be considered of low magnitude when compared to the number of red foxes being harvested and lethally removed in Delaware. Harvest and lethal removal of red fox can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of red fox lethally removed annually to the DNREC.

Gray Fox Population Impact Analysis

Like red foxes, the range of gray foxes has expanded from southern Canada into northern South America and from the Atlantic west into the Great Plains, the southwestern U.S. and portions of California and Oregon (Cypher 2003). Gray foxes are considered a woodland species but inhabit a variety of habitats including mixed agricultural/woodland landscapes (Cypher 2003). Little information is available on the social ecology of gray foxes (Cypher 2003). The basic social unit during the spring and summer is a mated pair and their pups (Fritzell 1987, Cypher 2003). Females produce a single litter of one to 10 (with an average of four) young each spring and young become independent by seven months (Fritzell 1987, Cypher 2003). The average home range of gray foxes in the eastern U.S. is highly variable (0.28–2.61mi^2) (Fritzell 1987). The population density of gray foxes has been estimated as ranging from 3.1 to 5.4 gray foxes per square mile although higher densities have been documented (Fritzell 1987). The State's gray fox population is unknown.

The number of gray foxes lethally removed by WS as well as the number harvested by hunters and trappers from 2012 to 2016 is shown in Table 3.9. Lethal removal of gray foxes can occur throughout the year, but many are harvested during hunting and trapping seasons. The average annual harvest from 2012 to 2016 was 190 gray foxes per year. The total number of gray foxes lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.9: The number of gray fox removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	278
2013	0	276
2014	0	253
2015	0	92
2016	0	51
AVERAGE	**0**	**190**

Direct, Indirect, and Cumulative Effects:
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 25 gray foxes annually under the proposed action alternative to manage damage or threats of damage.

The lethal removal of up to 25 gray foxes would represent 13.16% of the average number of gray foxes harvested annually (190) in Delaware from 2012 – 2016. Population data for gray fox in Delaware is currently not available. To determine an estimated population in Delaware, the best available data will be used. There are 380,000 acres of forestland (Forest Service_Annual Report 2017) and about 500,000 acres of cropland (NASS) in Delaware. Using the assumptions that only 50% of the forest and crop lands (440,000) throughout the state have sufficient habitat to support gray fox, that they are only found in these habitats, and densities average 3.1/mi^2, the gray fox population could be estimated as approximately 2,132 individuals. Considering gray fox inhabit a large variety of habitats, including suburban areas, and may occupy more than 50% of the forested and cropland habitat available, this is likely a conservative estimate. The annual lethal removal of 25 gray fox would represent 1.2% of the estimated population.

Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and the estimated population in the state, WS' proposed lethal removal should not have any significant direct or cumulative impact on gray fox populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of gray foxes being harvested and lethally removed in Delaware. Harvest and lethal removal of gray fox can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of gray fox lethally removed annually to the DNREC.

Raccoon Population Impact Analysis

Raccoons are distributed almost continuously across the U.S. (Gehrt 2003). They occupy a wide variety of habitats including woodlands, woodlands interspersed with fields, and areas with water (Gehrt 2003). Females produce one litter of 3-4 young per year (Gehrt 2003). The common social unit among raccoons is females with young but many animals use the same structures for shelter (as many as 23 raccoons have been observed using the same structure) (Sanderson 1987, Gehrt 2003). The average home range (12–12,000 acres) varies depending on habitat, season, age, and food availability (Sanderson 1987). The population density of raccoons has been estimated from <1 – 47 raccoons per acre (Sanderson 1987, DeGraaf and Yamasaki 2001, Gehrt 2003).

The number of raccoons lethally removed by WS as well as the number harvested by hunters/trappers from 2012 to 2016 is shown in Table 3.10. Lethal removal of raccoons can occur throughout the year, but many are harvested during hunting and trapping seasons. Raccoons taken during hunting and trapping seasons are reported during an annual mail surveys conducted by the DNREC. The average annual harvest from 2012 to 2016 was 4,130 raccoons per year. The total number of raccoons lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.10: The number of raccoons removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	3,449
2013	0	6,692
2014	0	3,434
2015	0	4,785
2016	0	2,290
AVERAGE	**0**	**4,130**

Direct, Indirect, and Cumulative Effects:
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 100 raccoons annually under the proposed action alternative to manage damage or threats of damage.

The lethal removal of up to 100 raccoons would represent 2.5% of the average number of raccoons harvested annually in Delaware. Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on raccoon populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of raccoons being harvested and lethally removed in Delaware. Harvest and lethal removal of raccoons can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report all raccoons lethally removed annually to the DNREC.

Striped Skunk Population Impact Analysis

Striped skunks are distributed across the U.S. in suitable habitat including open forest, grasslands, agricultural areas, wetlands, suburban and urban areas (Rosatte 1987, Rosatte and Larivière 2003). Females typically produce a single litter of 2–10 young a year, although second litters have been documented (Rosatte and Larivière 2003). Striped skunks are solitary with the exception of females with young and the use of communal shelter sites during periods of inclement weather (Rosatte 1987, Rosatte and Larivière 2003). Skunks are not territorial (Rosatte and Larivière 2003). The home range of a striped skunk fluctuates with season, feeding activities, and dispersal (Godin 1977). Skunk densities vary widely according to season, food sources and geographic area. Densities have been reported to range from one skunk per 77 acres to one skunk per 10 acres (Rosatte 1987).

The number of striped skunks lethally removed by WS to alleviate damage and threats as well as the number harvested by trappers and brokered by fur dealers from 2012 to 2016 is shown in Table 3.11. Although lethal removal of striped skunks can occur throughout the year, many are lethally removed during the trapping season. The DNREC conducts annual mail surveys on trappers to estimate harvest numbers. An estimated 119 striped skunks were harvested annually between 2012 – 2016 in Delaware. The total number of striped skunks lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.11: The number of striped skunks removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	63
2013	0	354
2014	0	73
2015	0	47
2016	0	57
AVERAGE	**0**	**119**

Direct, Indirect, and Cumulative Effects:
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 50 striped skunks annually under the proposed action alternative to manage damage or threats of damage.

No population estimates are available for striped skunks in Delaware. Striped skunks can be found in a variety of habitats across the state. Therefore, a population estimate will be derived based on the best available information for skunks to provide an indication of the magnitude of take proposed by WS to alleviate damage and threats of damage. There are about 500,000 acres acres of farmland in Delaware (NASS 2016). If only 50% of the farmland throughout the state has sufficient habitat to support striped skunks, skunks are only found on farmland, and skunk densities average one skunk per 77 acres, a statewide striped skunk population could be estimated at nearly 3,246 skunks. Skunks can be found in a variety of habitats, including urban areas, throughout the state; therefore, skunks likely occupy more than 50% of the farmland area in the state. However, to determine the magnitude of the proposed take by WS to alleviate or prevent damage, skunks occupying only 50% of the farmland area was used to provide a minimum population estimate. The annual lethal removal of 50 skunks would represent 1.5% of the estimated population.

Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the estimated statewide population, WS' proposed lethal removal should not have any significant direct or cumulative impact on striped skunks populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of striped skunks being harvested and lethally removed in Delaware. Harvest and lethal removal of striped skunks can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of striped skunks lethally removed annually to the DNREC.

River Otter Population Impact Analysis

Today, river otters are distributed across much of the eastern U.S., the Pacific Northwest and many western states where their range continues to expand (Raesly 2001, Melquist et al. 2003). They are found in habitats with a variety of both fresh, salt and brackish water wetlands, streams, ponds, lakes and rivers (Melquist et al. 2003). Females produce a single litter each year of 1–6 young (DeGraaf and Yamasaki

2001, Melquist et al. 2003). Social groups consist of a female and her young (Melquist et al. 2003). Where resources are abundant males may also form groups (Melquist et al. 2003). Otters are territorial (Melquist et al. 2003). Home range estimates range from 0.7 to 22 square miles ((DeGraaf and Yamasaki 2001). Population densities of river otters range from 1 otter per 1.2 mile to 1 otter per 10.6 mile of waterway (DeGraaf and Yamasaki 2001). The State's river otter population is unknown.

The number of river otters lethally removed by WS to alleviate damage and threats as well as the number harvested in the state by hunters and trappers from 2012 to 2016 is shown in Table 3.12. Although lethal removal of river otters can occur throughout the year, many are lethally removed during the trapping season. According to the DNREC an average of 31 river otters were harvested between 2012-2016. The total number of river otters lethally removed by other entities to alleviate damage or nuisance issues in the State is unknown.

Table 3.12: The number of river otter removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	77
2013	0	22
2014	0	43
2015	0	7
2016	0	8
AVERAGE	**0**	**31**

Direct, Indirect, and Cumulative Effects:
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 10 river otters annually under the proposed action alternative to manage damage or threats of damage.

There are approximately 2,500 miles of streams and rivers in Delaware along with over 2,950 acres of lakes, reservoirs, and ponds, with over 226,000 acres of wetlands (DNREC 2017). Otter are closely associated with aquatic habitats where they forage and den along shorelines. Using 2,500 miles of streams in Delaware and the low end of one otter per 10 miles of waterway would result in a statewide population estimate of 250 otter. If only 50% of those streams supported river otter, the minimum statewide river otter population could be 125 otter in Delaware. This would be a worst-case scenario since the otter population is likely to inhabit a much larger portion of the streams and rivers. In addition, otter also inhabit other aquatic habitats besides rivers and streams; therefore, the actual population is likely to be higher.

The lethal removal of up to 10 river otters would represent 8.0% of the conservatively estimated Delaware otter population. Given the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest and lethal removal occurring, WS' proposed lethal removal should not have any significant direct or cumulative impact on river otter populations. WS' lethal removal would be a limited component of the overall harvest and lethal removal and could be considered of low magnitude when compared to the number of river otters being harvested and lethally removed in

Delaware. Harvest and lethal removal of river otters can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired objectives. WS would report the number of river otters lethally removed annually to the DNREC.

White-tailed Deer Population Impact Analysis

White-tailed deer are distributed across the U.S. with the exception of Nevada, Utah and parts of Washington, Oregon, Idaho, Wyoming, Colorado, Arizona, New Mexico and California (Miller et al. 2003). Preferred habitat consists of forest with adjacent open habitat (DeGraaf and Yamasaki 2001, Miller et al. 2003). White-tailed deer produce 1–3 young once a year (DeGraaf and Yamasaki 2001). Social structure during the non-breeding season takes two forms; groups composed of a female, her young born that year and her young of previous years or groups composed of adult males (Miller et al. 2003). During the fall and winter these groups may fuse into larger groups (Miller et al. 2003). In the spring, reproductive females isolate themselves until fawns are born and have achieved 8–10 weeks of age (Miller et al. 2003). Home ranges are dependent on a variety of factors ranging in size from 146 to 4,593 acres (DeGraaf and Yamasaki 2001). Population densities vary depending on habitat and can easily exceed 30 deer per square mile (DeGraaf and Yamasaki 2001). The statewide population was estimated at 30,000 – 40,000 deer in 2009 (DNREC 2009).

The number of deer lethally removed by WS to alleviate damage and threats as well as the number harvested by hunters from 2012 to 2016 is shown in Table 3.13. Lethal removal of deer can occur under permits issued by the DNREC or during annual harvest seasons. Delaware allows for the harvest of six deer during the harvest season, with the possibility of additional tags being purchased. The average annual hunter harvest from 2012 to 2016 was 14,256 deer per year. The lowest harvest between 2012 and 2016 was 13,302 which occurred in 2012, while the highest harvest of 14,793 occurred in 2016.

Table 3.13: The number of white-tailed deer removed in Delaware between 2012 and 2016.

Year	WS' Lethal Removal	# of Animals harvested (DNREC)
2012	0	13,302
2013	0	14,263
2014	0	14,239
2015	7	14,681
2016	6	14,793
AVERAGE	**2.6**	**14,256**

Direct, Indirect, and Cumulative Effects:
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 deer annually under the proposed action alternative to manage damage or threats of damage.

The lethal removal of up to 1,000 white-tailed deer would represent 7% of the average number of deer harvested by hunters. WS' proposed removal would represent 3.3% of the low-end estimated population (30,000) and 2.5% of the high-end estimated population (40,000). Given the overall increasing trend of

deer harvested since 2012, and the limited lethal removal proposed by WS to alleviate damage and threats when compared to the overall harvest, WS' proposed lethal removal should not have any significant direct or cumulative impact on deer populations. WS' lethal removal would be a limited component of the overall harvest and could be considered of low magnitude when compared to the number of deer being harvested. Harvest and lethal removal of deer can only occur at the discretion of the DNREC. The DNREC ensures harvest and lethal removal occurs to achieve desired population objectives. WS would report the number of white-tailed deer lethally removed annually, which would ensure cumulative impacts would be considered as part of DNREC population management objectives for deer.

Feral Swine Population Impact Analysis

Feral swine, also known as feral hogs, feral pigs, wild pigs, wild boar, etc. are not native to the western hemisphere, and were first introduced by early settlers (Sweeney et al. 2003). As of 2012, feral swine were established in 38 U.S. states (Miller and Sweeney 2013). Not restricted by cold temperatures, feral swine have adapted to a variety of habitats including agricultural areas, hardwood forest, pine plantations, and both fresh and salt water wetlands (Sweeney et al. 2003). Feral swine breed year round and typically produce more than one litter per year of 3–8 but as many as 12 young (Sweeney et al. 2003, West et al. 2009). Social structure is characterized by lone males and groups of females and their young (Sweeney et al. 2003, West et al. 2009). Female groups typically consist of several adults and their young although groups of >25 have been recorded (Sweeney et al. 2003, West et al. 2009). Home range varies dramatically from a few hundred to several thousand acres (West et al. 2009). The population density of feral swine in Texas was found to range from 1.33 to 2.45 feral swine per square mile (Texas A&M 2014).

Currently, there are no known populations of feral swine in Delaware. If feral swine are detected, they and their damage may be addressed by the WS program in response to requests by federal agencies, state agencies, municipal agencies, or the public at any location. Agricultural producers may request assistance with managing damage to standing crops or disease threats to domestic livestock. Natural resource managers may request assistance to protect natural areas, parks or recreation areas, or T&E species. Public health agencies may request assistance in reducing feral swine densities where disease threats to people may exist.

Direct, Indirect, and Cumulative Effects:
To address any future requests for assistance associated with feral swine, the WS-Delaware program may use any legal methods among those outlined by the APHIS National Feral Swine Damage Management Program as suitable for feral swine damage management to annually remove up to 100 swine to ensure feral swine do not become established in Delaware. Feral swine would most likely be lethally removed by trapping and/or shooting. Feral swine captured using live-capture methods would be subsequently euthanized pursuant to WS Directive 2.505 or in cases where the animal is a pet or raised for the purpose of agricultural production, WS could transfer custody of the animal to Animal Control within the county of capture. Executive Order 13112 states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law; 1) reduce invasion of exotic species and associated damages, 2) monitor invasive species populations, provide for restoration of native species and habitats, 3) conduct research on invasive species and develop technologies to prevent introduction, and 4) provide for environmentally sound control and promote public education on invasive species. WS' lethal removal of feral swine would comply with this Executive Order. While elimination of feral swine would be beneficial to the environment, the removal of 100 feral swine annually would not pose any significant direct or cumulative impacts to the population throughout the Eastern U.S.

Wildlife Disease Surveillance and Monitoring

Under the proposed action / no action alterative, WS' could sample mammals captured live by WS or other entities, mammals that were sick or dying, or animals harvested by hunters for disease. The sampling (e.g., drawing blood, swabbing nasal cavities, collecting fecal samples) and the subsequent release of live-captured mammals would not result in adverse effects to mammal populations since those mammals would be released unharmed on site. Additionally, the sampling of mammals that were sick, dying, or harvested by hunters would not result in the additive lethal removal of mammals that would not have already occurred in the absence of WS' activities. Therefore, the sampling of mammals for disease as described above would not adversely affect the populations of any of the mammals addressed in this EA.

Alternative 2 – WS Would Address Mammal Damage Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats associated with mammals with technical assistance only. Despite no direct involvement by WS in resolving damage and threats, those persons experiencing damage 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 associated with mammals.

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, State, and local laws and regulations or those persons could take no action. Therefore, mammal populations in the State would not be directly impacted by WS from a program implementing technical assistance only.

Direct, Indirect, and Cumulative Effects:
The number of mammals lethally removed under this alternative would likely be similar to the other alternatives. Lethal removal of those species addressed in this EA can occur, depending upon the species, when they are causing damage or a nuisance or during hunting and trapping seasons.

With the oversight of the DNREC, it is unlikely that mammal populations would be significantly impacted, directly or cumulatively, 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 DNREC. 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 Mammal Damage

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

Despite no involvement by WS in resolving damage and threats associated with mammals, 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 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 could take action using those methods legally available to resolve or prevent damage as permitted by federal, State, and local laws and regulations or those persons could take no action.

Direct, Indirect, and Cumulative Effects:
Lethal removal of those species addressed in this EA could continue to occur since depending on the species, lethal removal can occur when they are causing damage or a nuisance, or during hunting and trapping seasons. The number of mammals lethally removed under this alternative and any direct or cumulative population impacts would likely be similar to the other alternatives. However, it is not expected that lethal removal would reach a level of significant direct or cumulative impacts to target wildlife populations.

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 DNREC. 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 misidentification and targeting of mammal(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 Non-target Animals, Including Threatened and Endangered Species

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

Alternative 1 – WS Would Continue to Address Damage 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 associated with mammals. 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) discussed in Chapter 2 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) but also several other SOPs including the following. WS personnel are trained and experienced in the identification of animal 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 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 DNREC to determine the potential risks to federally and state listed threatened and endangered species in accordance with the ESA and State 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. WS would only employ methods in response to a request for assistance after the property owner or manager has signed a document agreeing to allow specific methods be used on property they own and/or manage.

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 resources 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 significant adverse impacts on non-target populations of wildlife including threatened and endangered species under this alternative.

Eagles may occur in or near areas where damage management activities are conducted. 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, riding an ATV or driving a boat, 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

As previously mentioned, eagles may occur in or near areas where management activities are conducted 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 a snare within 50 feet of a 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 2003–2013 (Sauer et al. 2014). The number of bald eagles observed in Delaware during the Christmas Bird Count has shown a dramatic increasing trend since 1966 (National Audubon Society 2010).

All of the lethal methods listed in Appendix B could be available under this alternative.

> *Shooting* - 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.
>
> *Euthanasia* - 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.
>
> *Snare (cable device)* - 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 WS Directive 2.450. WS' recommendation of the use of snares as a method is not likely to increase the risk to non-targets.
>
> *Bodygrip Trap (e.g., Conibear)* - WS would use bodygrip traps 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 WS Directive 2.450. WS' recommendation of the use of bodygrip traps as a method is not likely to increase the risk to non-targets.

Rodenticides - A common concern regarding the use of rodenticides is the potential risk to non-target animals, including threatened and endangered species. Rodenticides would be used by WS in accordance with their label and WS Directive 2.401 to minimize risks to non-targets.

Direct, Indirect, and Cumulative Effects:
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 lethally removed. Methods would only be used by WS at the request of persons seeking assistance. Since 2012, WS-Delaware has only captured one non-target animal during mammal activites, which was a Virginia opossum that was successfully released. Those species lethally removed unintentionally by WS during management activities outlined in the need for action are common throughout Delaware and not considered to be of low density. WS' unintentional lethal removal of animals that could occur as part of damage management activities outlined in the need for action is limited and is not expected to have any impact on local or statewide populations. The species of animals lethally removed unintentionally in the past by WS is representative of animals that could be unintentionally removed by WS under the proposed action / no action alternative. Additionally, other species could be lethally removed unintentionally during mammal damage management activities. However, the lethal removal of those species would occur infrequently and not at levels that would cause significant adverse effects to those species' populations.

The capture and lethal removal that could occur as part of damage management activities to protect resources other than those outlined in the need for action are addressed in separate analyses 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. Average annual unintentional lethal removal by WS during activities to manage damage outlined in the need for action did not exceed one individual of any species. The cumulative impacts of lethal removal on non-target species are within the extent analyzed in separate analyses pursuant to the NEPA. Those documents concluded that WS would not adversely affect the viability of any wildlife species populations through program activities (USDA 2011, USDA 2014) .

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 DNREC, 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. 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 proposed 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 Delaware can be found in Appendix C. These lists were obtained and reviewed during the development of this EA.

Federally Listed Species - WS conducted an informal Section 7 consultation with the USFWS in which the USFWS concurred with WS' determination for performing beach-nesting bird protection. WS made a "may affect, but not likely to adversely affect" determination for piping plover (*Charadrius melodus*).

The USFWS concurred with WS' determination. All other species were concluded as a "no effect" determination.

State Listed Species - The current list of species designated as endangered, threatened, or special concern by the state, as determined by the DNREC, 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 or would not likely adversely affect 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 DNREC to determine the potential risks to eagles and federally and state listed threatened and endangered species in accordance with the Bald and Golden Eagle Protection Act, ESA and state 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. No indirect effects were identified for this issue.

Alternative 2 – WS Would Address Mammal Damage Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats associated with mammals 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, those persons experiencing damage caused by mammals could continue to alleviate damage by employing both non-lethal and lethal methods. All methods listed in Appendix B 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 as described under Alternative 1.

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, State, 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.

Direct, Indirect, and Cumulative Effects:
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. However, impacts would not be expected to be significant.

Alternative 3 – WS Would Not Address Mammal Damage

WS would not be involved with any aspect of managing damage associated with mammals. 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 associated with mammals would be referred to the DNREC, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with mammals, 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 could take action using those methods legally available to resolve or prevent damage as permitted by federal, State, and local laws and regulations or those persons could take no action.

Direct, Indirect, and Cumulative Effects:
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 mammals, the risks would be similar to Alternative 2. However, impacts would not be expected to be significant.

Issue 3 - 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 associated with mammals. 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 Mammal Damage 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)

discussed in Chapter 2 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 mammal 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. 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.

Direct, Indirect, and Cumulative Effects:
Non-chemical methods available for use under any of the alternatives are: live-capture traps (e.g., foot hold traps, cage traps), lethal traps (i.e., bodygrip traps) and snares (cable devices) (see Appendix B). The risk traps and snares (cable devices) pose to human health and safety are small to non-existent. 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 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 person. The use of chemical methods is strictly regulated by the DEA, EPA, FDA and DDA. Chemical methods used or recommended by WS would be registered as required by federal and state law (see Appendix B). When recommending chemical methods, WS would caution those persons against their misuse. Following label requirements eliminates risks to human health and safety.

The use of some pesticides is restricted to those persons who have been specifically trained and certified for their use. WS personnel that use restricted use pesticides would be certified as pesticide applicators and would be required to wear appropriate PPE they are provided with (WS Directive 2.601).

The use of chemical immobilization and euthanasia drugs or substances is restricted. WS personnel that possess or use these substances would be trained and certified in accordance with WS Directive 2.430. WS personnel that use these drugs or substances would be required to wear appropriate PPE they are

provided with (WS Directive 2.601). Additionally, "*the acquisition, storage, and use of* ...(these substances would be)... *in compliance with applicable program, Federal, State, and local law and regulations*" (WS Directive 2.430). When using immobilizing drugs, WS would adhere to all established withdrawal times agreed upon by WS, the DNREC, and veterinarian authorities. If WS receives a request to immobilize mammals during a period of time when the regulated harvest of those species was occurring or during period of time where the withdrawal period could overlap with a harvest season, WS would euthanize the animal or mark the animal with ear tags labeled with a "*do not eat*" warning. This would eliminate risks to human health and safety from persons consuming animals that had or potentially had immobilizing drugs remaining in their systems.

There has been no significant impacts to human safety occurring from WS' use of methods to alleviate damage associated with mammals in Delaware from FY 2012 to FY 2016. 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 significant direct, indirect or cumulative impacts are expected from the chemical components used or recommended by the WS program.

Alternative 2 – WS Would Address Mammal Damage Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats associated with mammals 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 associated with mammals, those persons experiencing damage could continue to alleviate damage by employing both non-chemical and chemical methods. All methods listed in Appendix B could be available under this alternative.

Direct, Indirect, and Cumulative Effects:
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, 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. However, impacts would not be expected to be significant.

Alternative 3 – WS Would Not Address Mammal Damage

Under this alternative, WS would not be involved with any aspect of managing damage associated with mammals. 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 associated with mammals would be referred to the DNREC, the DDA, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with mammals, 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, State, and local laws and regulations or those persons could take no action.

Direct, Indirect, and Cumulative Effects:
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 caused by mammals, the risks would be similar to Alternative 2. Additionally, impacts would not be expected to be significant.

Issue 4 – Humaneness and Animal Welfare Concerns

As described in Chapter 2, humaneness and animal welfare concerns associated with methods available to reduce damage associated with mammals 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 Mammal Damage 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. Under this alternative, WS could employ or recommend methods viewed as inhumane by some persons. This could include WS killing or capturing and either subsequently killing or immobilizing and then releasing target animals using the best and most appropriate method(s) available. WS' use of methods under the proposed action / no action alternative would adhere to applicable state and local laws and regulations as well as WS' Directives (see Appendix B for WS Directives specific to methods). These include but are not limited to guidelines for the types of devices or drugs which can be used, frequency in which capture devices must be checked and manner in which they must be applied. When recommending methods, WS would caution against their misuse.

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.

Direct, Indirect, and Cumulative Effects:

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. 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 2.

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 adverse impacts were identified for this issue.

Alternative 2 – WS Would Address Mammal Damage Using Technical Assistance Only

Under this alternative, WS would provide those persons requesting assistance with managing damage and threats associated with mammals 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 associated with mammals, 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.

Direct, Indirect, and Cumulative Effects:
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 mammals or the improper identification of the animal causing damage along with inadequate knowledge and skill in using methodologies to alleviate the damage or threats 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 persons requesting assistance and implementing methods are not as diligent or timely in checking methods. If those persons requesting 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 Mammal Damage

Under this alternative, WS would not be involved with any aspect of managing damage associated with mammals. All requests for assistance received by WS to resolve damage associated with mammals would be referred to the DNREC, the DDA, local law enforcement or animal control authorities and/or private entities.

Despite no involvement by WS in resolving damage and threats associated with mammals, 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.

Direct, Indirect, and Cumulative Effects:
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 associated with mammals. Therefore, those methods considered inhumane would continue to be available for use under this alternative. If those people experiencing damage 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.

3.2 ISSUES NOT CONSIDERED FOR COMPARATIVE ANALYSIS

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, 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.

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:

Effects of Mammal Damage Management Activities on Biodiversity

An issue identified as a concern is that managing mammal damage 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. Wild mammals are managed by the DNREC. Lethal removal of these animals can only occur at the discretion of the DNREC, which ensures that removal occurs to achieve desired population objectives for these species. 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 mammals 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, animals causing damage or posing threats 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. The amount of lead that becomes soluble in soil is usually very small (0.1-2.0%) (EPA 2005). 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. The study detected 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). 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 at high levels in areas with permanent water bodies present, the lead does not necessarily cause elevated lead contamination of water downstream. Ingestion of lead shot, bullets or associated fragments is not considered a significant risk to fish and amphibians (Rattner et al. 2008). 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). 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.

Lead ammunition (for hunting or target shooting) is only one of many sources of lead in the environment. Other sources which can settle into soil and water include lost fishing sinkers (an approximated 3,977 metric tons of lead fishing sinkers are sold in the United States annually; Rattner et al. 2008), and airborne emissions from metal industries (e.g., lead smelters, iron production, steel production), manufacturing industries, and waste incineration (EPA 2013*a*). Since in many damage situations, the lethal removal of wild mammals addressed in this document could occur at any time or during hunting and trapping seasons, WS' assistance with removing animals causing damage 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 associated with mammals in Delaware may be funded by a variety of sources including, but not limited to, federal appropriations, the State of Delaware, and other cooperative funding. 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 WS-Delaware program. The remainder of the WS-Delaware program is funded by cooperative, federal, and non-federal funding.

3.3 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 mammals by WS would not have a significant impact on overall mammal populations, but some short-term local reductions may occur. Additionally, WS would not have a significant direct, indirect, or cumulative impact on the ability of hunters or trappers to harvest species targeted by management activities. 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. 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. 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 reduce damage or threats associated with mammals, as described in the proposed action/ no action alternative, would not result in significant adverse cumulative impacts on the quality of the human environment.

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APPENDIX B: METHODS AVAILABLE FOR PREVENTING, REDUCING AND ELIMINATING DAMAGE AND THREATS ASSOCIATED WITH MAMMALS IN THE STATE OF DELAWARE

A variety of methods are potentially available to the WS program. Various federal, State, 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. 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 damage associated with mammals. 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 generally 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 damage associated with mammals 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 the 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 to stay with livestock day and night generally 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 managers of signs of damage sooner than infrequent monitoring may.

Crop Selection and Scheduling: In areas where damage to crops from mammals occurs, different crops can be planted that are less attractive to the mammals causing damage. Alternatively, crops can be planted at an earlier or later date to coincide with periods when there is a greater availability of natural food items. This practice depends on the species causing damage, the availability of alternate food sources, and the market for alternative crops. Research has been conducted on damage resistant crop varieties with little success.

Lure Crops: If depredation cannot be avoided by careful crop selection or a modified planting schedule, lure crops can sometimes be used to mitigate the potential loss. Lure crops are crops planted or left for consumption by wildlife as an alternate food source. To improve the efficacy of this technique, frightening devices should be used in nearby non-lure crop fields and wildlife should not be disturbed in the lure crop fields. This approach provides relief for critical crops by sacrificing less important or specifically planted fields. Establishing lure crops is sometimes expensive, requires considerable time and planning to implement, and may attract other unwanted species to the area. Implementation of this method is limited by the authority of those involved to manage the property.

Beaver Dam Breeching and Removal: This method involves the partial or complete removal of materials that beavers have deposited to obstruct the flow of water or alternatively the routing of water around or through these materials to restore the flow of water. Beavers construct dams from logs, sticks, mud and other natural materials. The removal of beaver dams is regulated under section 404 of the Clean Water Act (40 CFR 232.2). Upon receiving a request to conduct direct operational assistance, WS would visually inspect the dam and the associated water impoundment to determine if characteristics exist at the site that would meet the definition of a wetland under section 404 of the CWA (40 CFR 232.2). If necessary, WS would notify the entities requesting assistance that a permit might be required to remove the dam and to seek guidance from the United States Army Corps of Engineers and the DNREC. When providing operational assistance, WS would remove beaver dams in accordance with federal and state laws and regulations for environmental protection. Damage caused by beavers could be addressed in a variety of ways.

Pipe Systems: These systems are designed to modify beaver behavior through deception (Taylor and Singleton 2014). Beavers may associate the sound of and movement of water with a need to dam or obstruct the flow of water (Taylor and Singleton 2014). These systems use pipes or channels to move water through materials deposited by beavers (i.e., dams) to provide relief by restoring some of the flow of water. Pipe systems may be made of metal, wood, plastic or other materials. Pipes may or may not be perforated. These systems require regular maintenance to be effective.

Fence Systems: These systems are designed to exclude beavers from the area around a culvert, placing materials in the culvert or simply be a modification of the culvert design that inhibits beavers from blocking the culvert (Jensen et al. 1999, Taylor and Singleton 2014). For additional information see **Conventional Fencing**.

Water Flow Devices: These devices use a combination of both pipes and fencing to move water through materials deposited by beavers. Examples include the Clemson Pond Leveler and

flexible pipe and fencing systems (e.g., Castor Master™, double filters, Flexible Pond Leveler™) (Taylor and Singleton 2014). The devices require regular maintenance and cannot be installed at all locations (e.g., topography inhibits installation) (Taylor and Singleton 2014).

Manual: Manual removal involves the removal of materials with hand rakes, pitch forks, shovels, winches or other similar tools. It may also involve the use of heavy equipment. WS would not employ but may recommend the use of heavy equipment to resolve damage associated with beaver dams.

Habitat Management: 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, or trees can be pruned or removed to eliminate a ladder from which raccoons can gain access to an attic. This vegetation may also serve as areas to feed on or cache (hide food for future consumption) food. 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 (e.g., wetlands). 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, 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.

PHYSICAL EXCLUSION

Physical exclusion methods restrict the access of mammals to resources or areas where damage is occurring. These methods can provide effective prevention of damage in many situations. However, exclusionary devices which are 100% effective at excluding mammals can be more costly than the value of the resources being protected, especially for large areas. In addition, some exclusionary devices require labor intensive maintenance which can further reduce their cost-effectiveness.

Confinement: Livestock or pets 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.

Conventional Fencing: Fences, either temporary or permanent, can be effective in excluding mammals. With any type of fencing the height of the fence must be tall enough, the distance between the fence and the ground or the distance between wires must be small enough to exclude animals. Many mammals are able to climb over, jump over, dig under or pass through many fences if motivated. For this reason, barbed wire, rail, picket, cable wire and non-electrified high-tensile fences may not be effective at excluding mammals. Woven wire, wire mesh or stockade fences, although not mammal proof, when properly installed and maintained (e.g., mesh must be kept stretched tight and mesh must be attached securely to posts or the ground) do provide a barrier. Gates or doors reinforced with fencing or panels which leave minimal gaps when closed or which incorporate sills ensures the integrity of woven wire or mesh fence. Fences with overhangs at the top and aprons at the bottom are effective at excluding additional animals. Fencing requires maintenance because animals are quick to exploit gaps.

Electric Fencing: Electric fences can be built for temporary or permanent use. Temporary electric fences can be constructed of polywire, poly tape or ElectroNet™. Permanent fences can be constructed with either multiple single strand wires or a combination of woven wire or wire mesh and single strand wires. In general, electric fencing is effective at reducing damage but no fence is 100% effective at excluding all mammals because animals that are willing to expose themselves to electric shock, can avoid electric wires while passing through, digging under or jumping over fences or exploiting times when the fence wasn't charged. Also, some species, including 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.

Barriers: Cliff faces, bodies of water, the wall of a barn and a variety of other natural and manmade structures provide a barrier to mammal movements and restrict access to resources. Used in conjunction with proper fencing these barriers can be effective. Barriers made of various kinds of materials (e.g., flashing, hardware cloth, steel wool, copper gauze, sheet metal, foam caulk, quick setting concrete) can be applied, arranged or designed to effectively exclude mammals. For example, in parks and similar areas trash containers which people can open but black bears and other wildlife cannot can be installed. Dams can be constructed using stone rip-rap to prevent muskrats from burrowing into them. Rigid plastic mesh or heavy paper can be wrapped around the trunks of trees to protect them from cottontail rabbits.

> **Predator Exclosures on Nests:** Studies have shown that predator exclosures can help minimize predation to piping plover and other shorebird nests (Smith et al. 2011). However, this minimization is largely limited to eggs, as chicks leave the nest bowl soon after hatching. Several authors have noted that predators will associate exclosures with a potential meal causing increased predation on adults (Nol and Brooks 1982, Johnson and Oring, 2002, Neuman et al. 2004, and Isaksson et al. 2007). Therefore the use of exclosures should be carefully evaluated prior to use (Smith et al. 2011).

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 periodic, 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 remote control vehicles, or with non-motorized or motorized boats or motor 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 mammals 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, pets or non-target wildlife when they are used in their vicinity.

Visual Stimuli: Different types of lights (e.g., floodlights, strobe lights, lasers, revolving lighting units), scarecrows or effigies (which mimic humans or a predator), moving and or reflective material (e.g., mylar tape), and other threatening images (some animals have a fear of new objects) have been used with mixed results. In general, the type of stimuli, the number of devices, 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 stimuli and they are not generally effective in the long-term. Devices activated by motion, body-heat or radar 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 mammals. Unfortunately, for many species of mammals there are no known repellants that are effective after repeated exposure. These 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 2002). The device was designed specifically to reduce predation on livestock (Linhart 1984, Linhart et al. 1984, Linhart et al. 1992) but can be used in other applications. 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 turn on when activated by the target animal. 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 similar devices can be activated by motion, body-heat or radar. These and other similar devices can be temporarily effective in reducing damage in some situations.

Projectiles: Different types of projectiles (water from a hose, paint balls, sticks, small rocks etc.) maybe used to frighten animals. 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. Guard dogs have also been used to protect agricultural crops from white-tailed deer (VerCauteren et al. 2005). Effectiveness is improved when combined in conjunction with other methods (Walton and Field 1989).

> ***Mixed Species Grazing:*** Pasturing sheep which have been bonded to cattle with cattle has been shown to reduce predation (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 (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 did bond well with sheep and traveled and grazed with sheep that were traveling and grazing with heifers (Hulet et al. 1989). Although cattle are predated upon, predation levels on cows is much lower than that of sheep and goats. The presence of cattle may be adequate to act as a predation deterrent.

CAPTURE WITH LIVE CAPTURE DEVICES

Mammals can be live captured through the use of several methods listed and described in detail below. Upon capture, animals could be relocated or euthanized. However, in most situations animals captured in live traps are subsequently euthanized (see lethal methods). For discussion of why animals are not generally relocated see Section 3.2. Wild mammals are managed by the DNREC and translocation could only occur under the authority of the DNREC. Cats and dogs are managed by local law enforcement and animal control authorities. WS would return cats and dogs to their owners, transfer them to animal control authorities, transfer them to the property owner or release them onsite. 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 and non-target animals.

Hand Capture: Hand capture involves using hands to take hold of an animal.

Catch Poles: Catch poles consist of a long pole with a loop of cable at one end and a tightening / release mechanism on the other. Use involves slipping the loop over the animal's head and then tightening it. Commonly used by animal control professionals.

Nets: Open-meshed material fashioned in a manner to trap, catch or ensnare.

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. A variation of the hand net is a round throw-net with weights at the edges of the net, similar to that used for fishing.

Cannon / Rocket Nets: Cannon or rocket netting involves setting bait in an area that would be completely contained within the dimensions of a manually propelled net. The launching of the rocket net occurs too quickly for the animals to escape.

Net Gun: This technique fires a net from a shoulder mounted gun which captures the target animal.

Bow Nets: Bow nets are small circular net traps. The nets are hinged and spring loaded so that when the trap is set it resembles a half moon. The net is set over a food source and triggered by an observer using a pull cord.

Mist Nets: Mist nets, made of a very fine mesh, are hung vertically in a drape like fashion. Bats become entangled when they fly into it. These nets are generally used for capturing bats entrapped in structures. Mist nets are monitored closely, to ensure that any captured bats can be promptly removed.

Drop Nets: Drop nets are set above a food source and triggered by an observer.

Cage Traps: These traps, which are typically fully enclosed, are used to capture animals alive. Traps are baited with foods or other items attractive to the target animal (see **ATTRACTANTS** below). 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. Some target animals including canids avoid cage traps (Phillips and Schmidt 1994, Shivik et al. 2005). Individual non-target animals may 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.

Box Traps: Box traps are usually rectangular, made with wood or metal supports and heavy gauge wire mesh. Animals enter through door(s) which are typically triggered to close when weight is applied to a pan or treadle or remotely by an observer. Doors may also be triggered to close by behavior specific to the target animal (see **Corral Trap** for examples). Sherman™ traps are a specific type of box trap made of sheet metal instead of wire mesh and designed to capture small mammals or Eastern chipmunks. Clover traps are a specific type of box trap made with netting instead of wire mesh and designed specifically to capture deer.

Suitcase Trap (e.g., Handcock™, Bailey™): As the name suggests, suitcase traps are shaped like a suitcase or clam shell with two identical halves that close to capture an animal when the triggering mechanism is engaged. Specifically designed for beaver, these traps have also been modified to capture otter.

Culvert Trap: Made of steel culverts or similar materials these traps have a door on one or both ends. Usually mounted on trailers, these traps are specifically designed to capture black bears. The door(s) are triggered to close when the animal engages a trigger mechanism.

Corral Trap: Corral traps may be constructed from steel or wood supports with wire fencing and are typically circular in shape. They are open at both the top and bottom. These traps are used to capture animals alive. Traps are baited with foods or other items attractive to the target animal (see **ATTRACTANTS** below). Animals enter through door(s) which are triggered by an observer, a trigger mechanism, or root stick. Alternatively, doors may be of a one way design, exploiting an animal's natural tendencies. For example, feral swine exhibit rooting behavior which makes them susceptible to being trapped in traps with doors that are hinged at the top and tilted inward at the bottom, and allow the animal to root underneath the door and enter the trap, but not exit.

Live-restraint Traps: These devices are designed to capture animals alive and unharmed. 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 (e.g., AFWA 2014*a*; 2014*b*; 2014*c*). 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*:* Foot-hold traps are spring powered devices set 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. Foot-hold traps are difficult to keep operational during wet or freezing conditions and may require more time and labor than other methods.

***Enclosed Foot-hold Traps**:* Enclosed foot-hold traps are spring powered devices staked into the ground which grasp and restrain an animal by its foot when the animal reaches through a small opening to investigate an attractant (e.g., EGG™ Trap, Lil' Grizz Get'rz™ Trap, Duffer's™ Trap etc.). These traps are specifically designed to capture raccoons and opossums. Non-target animals are excluded not only because of the size of the opening but also because of the dexterity required to pull on a lever and trigger the trap. 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.

Glue Boards: These devices consist of a rigid piece of plastic, cardboard or similar material with the horizontal surface coated in an adhesive. They may be enclosed or open. Animals making contact with the adhesive are restrained. Careful placement of traps at locations likely to capture target animals and exclude non-target animals and the use of appropriate attractants (see **ATTRACTANTS** below) increases the selectivity of this method. WS would only use glue boards to address small mammals (i.e., insectivores and rodents). As with all live capture devices, traps would be checked frequently and target animals would be subsequently euthanized (see lethal 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, corral traps, live-restraint traps) 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. These 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 target animals 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 individuals 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 to other canids. Dogs trained and used for these purposes 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.

JUDAS PIGS

This technique involves attaching a radio and / or GPS transmitter to a feral swine that has been captured and then releasing it at the site of capture. The animal would be monitored using signals emitted from the transmitter. Once this animal or "Judas pig" has joined other feral swine, those feral swine are either lethally removed or become additional Judas pigs. The original animal with the transmitter may be lethally removed or released to join additional feral swine and the process repeated. If Judas pigs sustain injuries and it is determined that they would not survive during application of this method by WS, they will be euthanized in accordance with WS Directive 5.505. WS would handle Judas pigs in compliance with all WS SOPs and WS Directives.

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. Currently, the only reproductive inhibitor that is registered with the EPA for use in any of the species addressed in this document is GonaCon™. GonaCon™ was officially registered by the EPA in 2009 for use in reducing fertility in female white-tailed deer. According to the label, only WS or state wildlife management agency personnel or individuals working under their authority can use GonaCon™. However, in order for GonaCon™ to be used in any given state, the product must also be registered with the state and approved for use by the appropriate state agency responsible for managing wildlife. GonaCon™ is not currently registered for use in Delaware. However, if GonaCon™ or other reproductive inhibitors become available to manage those species addressed in this document the State, their use could be evaluated under the proposed action alternative as a method available that could be used in an integrated approach to managing damage.

Repellents: Chemical repellents are non-lethal chemicals used to discourage or disrupt particular behaviors of wildlife. There are three main types of chemical repellents: olfactory, taste, and tactile. Effective and practical chemical repellents should be nonhazardous to wildlife; nontoxic to humans, animals and the environment; resistant to weathering; easily applied; reasonably priced; and capable of

providing good repellent qualities. The reaction of different individual animals to a single chemical formulation varies and this variation in repellency may be different from one habitat to the next. Examples include but are not limited to; Go Away™, Deer B Gon®, Ro-pel®, Deer Away®, Deer Off®, Liquid Fence®, Deer Stopper®, Deer Out®, and Rabbit & Groundhog Out®. Chemical repellents are strictly regulated, and suitable repellents are not available for many mammal species or wildlife damage situations.

Chemical Immobilization Drugs: The use of chemical immobilization drugs is restricted. WS personnel that possess or use these substances would be trained and certified in accordance with WS Directive 2.430. WS personnel that use these drugs or substances would be required to wear appropriate PPE they are provided with (WS Directive 2.601). Additionally, "*the acquisition, storage, and use of* ...(these substances would be)... *in compliance with applicable program, Federal, State, and local law and regulations*" (WS Directive 2.430). WS would capture animals using live capture devices and handle animals in compliance with all WS SOPs and WS Directives (see Live Capture Devices above).

Ketamine Hydrochloride (e.g., Ketaset®, Vetalar®)*:* Ketamine is an anesthetic or type of drug that produces anesthesia (more specifically a cyclohexane or dissociative anesthetic) (Kreeger 1999). Widely used in wildlife, it causes sections of the nervous system to disassociate, eliminating pain (Haigh 1982, Kreeger 1999). These drugs are also thought to have amnesic properties (animals cannot remember the event) (Kreeger 1999). When used alone, ketamine is a poor muscle relaxant and may produce seizures (Haigh 1982, Kreeger 1999). For this reason, ketamine is usually used with other drugs such as xylazine (see *Xylazine* below).

Telazol® (Tiletamine Hydrocloride and Zolazepam Hydrocloride)*:* Telazol® is an anesthetic or type of drug that produces anesthesia (more specifically a cyclohexane or dissociative anesthetic) (Kreeger 1999). It is mixture of two drugs, tiletamine and zolazepam. It causes sections of the nervous system to disassociate, eliminating pain (Kreeger 1999). These drugs are also thought to have amnesic properties (animals cannot remember the event) (Kreeger 1999). The combination of drugs suppresses undesirable side effects, speeds the time it takes for the drug to take effect and reduces the amount of drug required (Haigh 1982).

Xylazine Hydrochloride (e.g., Romprun®, Cervizine™, AnaSed®): Xylazine is a sedative (Kreeger 1999). It acts on the central nervous system providing muscle relaxation and loss of sensitivity to pain (Kreeger 1999). Commonly used with other drugs such as ketamine to produce relaxed anesthesia (see *Ketamine* above). The combination of these drugs suppresses undesirable side effects (e.g., the muscle tension commonly associated with Ketamine).

LETHAL METHODS (NON-CHEMICAL)

Recreational Hunting and Trapping: Where appropriate, WS recommends that those persons experiencing damage and threats associated with mammals consider hunting or trapping at the damage site as an option for reducing damage. Lethal removal of wild animals addressed in this EA can occur, depending upon the species and when they are causing damage or a nuisance or during regulated hunting and trapping seasons. 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. Animals removed by WS are killed as quickly and humanely as possible in accordance with WS Directive 2.505. WS employment of this method may include but is not limited to the use of vehicles (including aircraft), elevated platforms, illuminating devices (e.g., spotlights, night vision, Forward Looking Infrared Devices (FLIR)), suppressors, and attractants (e.g., bait, calling, decoy dogs). 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 are dogs trained to attract or decoy 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. WS would use aircraft for the application of this method in compliance with WS Directive 2.620 and all federal and state laws and regulations.

Live Capture Followed by Non-Chemical 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 or cervical dislocation (in the case of small mammals). WS would kill animals as quickly and humanely as possible in accordance with WS Directive 2.505.

> ***Cervical Dislocation:*** This method is sometimes used to euthanize small mammals which are captured in live traps (e.g., Sherman traps). The animal is stretched and the neck is hyper-extended and dorsally twisted to separate the first cervical vertebrae from the skull. The AVMA approves this technique as a humane method of euthanasia and states that cervical dislocation when properly executed is a humane technique for euthanasia of small mammals (i.e., insectivores and rodents) (AVMA 2001). Cervical dislocation is a technique that may induce rapid unconsciousness, does not chemically contaminate tissue, and is rapidly accomplished (AVMA 2001).

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 foxes for bearing and rearing young (Parker 1995, Cypher 2003). 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 **gas cartridges)** or via live capture followed by euthanasia. WS would kill animals as quickly and humanely as possible in accordance with WS Directive 2.505.

Bodygrip Traps: Designed to quickly and humanely kill the target animal that activates it, these spring driven devices have one or two jaws that close on the top or both the top and bottom of animal's neck. Following Best Management Practices, which are carefully researched recommendations, ensures that standards for animal welfare, efficiency, selectivity, practicality and safety are met. 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. WS would use bodygrip traps 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.

> ***Rotating Jaw Traps:*** (e.g., Conibear™ bodygrip trap, Bridger™ bodygrip trap, etc.). These two jawed devices are most commonly set underwater for the capture of aquatic rodents. Traps are specifically designed in different sizes for different sized animals. Traps are triggered to close when the animal attempts to move through the jaws and trips the wire triggers. Triggers can be configured to exclude non-target animals. Rotating jaw traps can also be set within an enclosure (e.g., a tube or box) in a manner that excludes larger animals (i.e., the size of the enclosure, size of the opening, and distance from the opening to the trap serve to exclude non-targets). 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.

***Snap Traps*:** Commonly known as mouse or rat traps, snap traps have a single jaw attached to a piece of wood or other stiff material. The trap is triggered to close when the baited treadle is disturbed. 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.

LETHAL METHODS (CHEMICAL)

The use of chemical methods is strictly regulated.

All pesticides have to be registered with the 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 DDA 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.

All pesticides used by WS are registered as required by the FIFRA. 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.

Pharmaceutical drugs, including those used in wildlife capture and handling are registered with the FDA and must be stored and used in compliance with both FDA and DEA regulations. These regulations are intended to ensure minimal adverse effects to humans, animals and the environment. Those possessing or using drugs must be registered to do so with the DEA under the Controlled Substances Act. Those using drugs must also comply with the Animal Medicinal Drug Use Clarification Act (AMDUCA).

All euthanasia and immobilization drugs or substances used by WS or recommended by WS would be registered with the FDA, and stored and used in compliance with Federal and state laws and regulations as required. WS personnel that possess or use these substances would be trained and certified in accordance with WS Directive 2.430. Additionally, "*the acquisition, storage, and use of* ...(these substances would be)... *in compliance with applicable program, Federal, State, and local law and regulations*" (WS Directive 2.430). When using immobilizing drugs, WS would adhere to all established withdrawal times agreed upon by WS, the DNREC, and veterinarian authorities. If WS receives a request to immobilize mammals during a period of time when the regulated harvest of those species was occurring or during period of time where the withdrawal period could overlap with a harvest season, WS would euthanize the animal or mark the animal with ear tags labeled with a "*do not eat*" warning. This would eliminate risks to human health and safety from persons consuming animals that had or potentially had immobilizing drugs remaining in their systems. Chemical immobilization and euthanasia drugs or substances are only used on private, public, or tribal property sites with authorization from the property owner or manager.

Gas Cartridges *(EPA Reg. No. 56228-2, others),* **and 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 woodchuck burrow (gas cartridge) or coyote or red fox den (large gas cartridge) 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 2001). Gas cartridges are registered for use in burrows being actively used by woodchucks. 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. Burrows or 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.

Sodium Pentobarbital (Beuthanasia®-D, Fatal-Plus®, etc.**):** Sodium pentobarbital is a type of anesthetic (a barbiturate) that causes death by respiratory failure. WS would only administer sodium pentobarbital via direct injection after target animals were captured using live capture devices and immobilized (see Live Capture Devices and Chemical Immobilization Drugs above). This method is recognized by the AVMA as an acceptable method of euthanasia (AVMA 2013). The use of sodium pentobarbital is restricted. WS personnel that possess or use these substances would be trained and certified in accordance with WS Directive 2.430. WS personnel that use these drugs or substances would be required to wear appropriate PPE they are provided with (WS Directive 2.601). Additionally, "*the acquisition, storage, and use of* ...(these substances would be)... *in compliance with applicable program, Federal, State, and local law and regulations*" (WS Directive 2.430). Euthanasia conducted by WS would be done in accordance with WS Directive 2.505. Euthanized animals would be disposed of in accordance with WS Directives 2.515 and 2.430 to prevent exposure to non-target animals.

Potassium Chloride: Potassium chloride causes death by cardiac arrest. WS would only administer potassium chloride via direct injection after target animals were captured using live capture devices and immobilized (see Live Capture Devices and Chemical Immobilization Drugs above). This method is recognized by the AVMA as an acceptable method of euthanasia (AVMA 2013). The use of potassium chloride is not restricted. WS personnel that use these drugs or substances would be required to wear appropriate PPE they are provided with (WS Directive 2.601). Euthanasia conducted by WS would be done in accordance with WS Directive 2.505. Euthanized animals would be disposed of in accordance with WS Directives 2.515 and 2.430.

Carbon Dioxide (CO_2): Carbon dioxide is sometimes used to euthanize mammals which are captured in live capture devices (se**e** Live Capture Devices above). Live animals are placed in a container such as a plastic five gallon bucket or chamber which is then sealed. CO_2 gas is released into the bucket or chamber and the animals quickly die after inhaling the gas. This method is approved as a euthanizing

agent by the AVMA (AVMA 2001). CO_2 gas is a byproduct of animal respiration, is common in the atmosphere, and is required by plants for photosynthesis. It is used to carbonate beverages for human consumption and is also the gas released by dry ice. The use of CO_2 by WS for euthanasia purposes is exceedingly minor and inconsequential to the amounts used for other purposes by society. Euthanasia conducted by WS would be done in accordance with WS Directive 2.505.

RODENTICIDES

Rodenticides are pesticides that kill rodents. They are categorized according to how they work. Rodenticides which interfere with normal blood clotting are called anticoagulants. Rodenticides that work in other ways are called non-anticoagulants. Rodenticide products which are not restricted-use chemicals and therefore available for use by persons without a certified pesticide applicator's license contain rodenticides from both of these groups (EPA 2016). Under the proposed action/no action alternative, WS would only provide direct operational assistance with small mammals to manage damage or threats to agriculture, natural resources or to property and human health and safety relative to aviation safety. When recommending these methods, WS would caution those persons against their misuse.

Anticoagulants: Anticoagulants interfere with blood clotting and cause death from excessive bleeding. First-generation anticoagulants require several doses to cause death (e.g., chlorpophacinone, diphacinone and warfarin). Second-generation anticoagulants are more likely to cause death after a single dose (e.g., brodifacoum, bromadiolone, difenacoum, and difethialone). Anticoagulants would be used by WS in accordance with the label (EPA 1998*a*, EPA 2008, EPA 2013*b*), WS directives and SOPs to reduce risks to humans, non-target animals and the environment.

Non-Anticoagulants: Non-anticoagulants may include the active ingredients bromethalin, cholecalciferol and zinc phosphide (EPA 2016). Both bromethalin and cholecalciferol are active ingredients in rodenticides available for use without a certified applicators license. Zinc phosphide is only available for use to certified applicators. Non-anticoagulants would be used by WS in accordance with the label (EPA 1998*a*, EPA 1998*b,* EPA 2008, EPA 2013*b*), WS directives and SOPs to reduce risks to humans, non-target animals and the environment.

> ***Zinc Phosphide*** *(EPA Reg. No. 56228-3, 56228-6, others)**:*** Zinc phosphide is a restricted use pesticide and would therefore be available to persons with a certified applicators license under any of the alternatives. When ingested, zinc phosphide comes into contact with stomach acid and water producing phosphine gas which is absorbed through the stomach lining (EPA 1998*b*, Proudfoot 2009). Death by circulatory failure occurs because phosphine inhibits cellular respiration (EPA 1998*b*, Proudfoot 2009). Different formulations of zinc phosphide are registered for use with a variety of rodents.
>
> A common concern regarding the use of chemicals is the risk to humans, non-target animals and the environment. Zinc phosphide would be used by WS in accordance with label directions, WS Directives 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; proper storage and disposal. Risk to applicators would be mitigated when used in accordance with the label (e.g., wearing long-sleeve shirt and long pants, shoes and sox, chemical-resistant gloves etc.) (EPA 1998*b*). Following label requirements also mitigates risks to the public, non-target animals and the environment (EPA 1998*b*, EPA 2008). For example, label requirements specify that bait stations (devices which must meet specified criteria confirmed by testing to restrict access) must be used where children or non-target animals may be exposed (EPA 1998*b*, EPA 2008). Euthanized animals would be

disposed of in accordance with WS Directives 2.515 and 2.430 to prevent exposure to non-target animals.

APPENDIX C: STATE ENDANGERED SPECIES LISTED IN DELAWARE[1]

[1]List obtained from < http://www.dnrec.delaware.gov/fw/NHESP/information/Pages/Endangered.aspx> on October 16, 2017.

COMMON NAME	SCIENTIFIC NAME	STATUS
Birds		
Pied-billed Grebe[BR]	*(Podilymbus podiceps)*	BR

Northern Harrier[BR]	*(Circus cyaneus)*	BR
Broad-winged Hawk[BR]	*(Buteo platypterus)*	BR
Black-Crowned Night-Heron	*(Nycticorax nycticorax)*	
Yellow-Crowned Night-Heron	*(Nyctanassa violacea)*	
American Kestrel	*(Falco sparverius)*	
Red Knot	*(Calidris canutus)*	
Piping Plover	*(Charadrius melodus)*	
Short-eared Owl [BR]	*(Asio flammeus)*	BR
American Oystercatcher	*(Haematopus palliatus)*	
Black Rail	*(Laterallus jamaicensis)*	
Upland Sandpiper	*(Bartramia longicauda)*	
Black Skimmer	*(Rynchops niger)*	
Henslow's Sparrow	*(Ammodramus henslowii)*	
Common Tern[BR]	*(Sterna hirundo)*	BR
Forster's Tern[BR]	*(Sterna forsteri)*	BR
Least Tern	*(Sterna antillarum)*	
Cerulean Warbler	*(Setophaga cerulea)*	
Hooded Warbler [BR]	*(Setophaga citrina)*	BR
Swainson's Warbler	*(Limnothlypis swainsonii)*	
Sedge Wren	*(Cistothorus platensis)*	
Reptiles		
Leatherback Sea Turtle[E]	*(Dermochelys coriacea)*	E
Atlantic Ridley Sea Turtle[E]	*(Lepidochelys kempii)*	E
Green Sea Turtle[T]	*(Chelonia mydas)*	T
Loggerhead Sea Turtle[T]	*(Caretta caretta)*	T
Bog Turtle[T]	*(Clemmys muhlenbergii)*	T
Corn Snake	*(Elaphe guttata guttata)*	
Amphibians		
Eastern Tiger Salamander	*(Ambystoma tigrinum tigrinum)*	
Barking Treefrog	*(Hyla gratiosa)*	
Mammals		
Delmarva Fox Squirrel [E]	*(Sciurus niger cinereus)*	E
Fish		

Atlantic Sturgeon	*(Acipenser oxyrhynchus)*	
Mollusks		
Yellow Lampmussel	*(Lampsilis cariosa)*	
Eastern Lampmussel	*(Lampsilis radiata)*	
Dwarf Wedgemussel[E]	*(Alasmidonta heterodon)*	E
Eastern Pondmussel	*(Ligumia nasuta)*	
Brook Floater	*(Alasmidonta varicosa)*	
Tidewater Mucket	*(Leptodea ochracea)*	
Insects		
Little White Tiger Beetle	*(Cicindela lepida)*	
White Tiger Beetle	*(Cicindela dorsalis)*	
Seth Forest Scavenger Beetle	*(Hydrochus sp.)*	
Frosted Elfin	*(Incisalia irus)*	
Bethany Firefly	*(Photuris bethaniensis)*	
Hessel's Hairstreak	*(Mitoura hesseli)*	
King's Hairstreak	*(Satyrium kingi)*	
Rare Skipper	*(Problema bulenta)*	
Mulberry Wing	*(Poanes massasoit chermocki)*	

BR Breeding population only, T Federally listed Threatened Species, E Federally listed Endangered Species

Fish and Wildlife Status Codes and Definitions:

E (Endangered): Any species which is in danger of extinction throughout all or a significant portion of its range.

T (Threatened): Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.