FINAL ENVIRONMENTAL ASSESSMENT

MAMMAL DAMAGE MANAGEMENT
IN MISSISSIPPI

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

In cooperation with:

TENNESSEE VALLEY AUTHORITY

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ACRONYMS

APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
BAM	Butorphanol-Azaperone-Medetomidine
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FR	Federal Register
FY	Federal Fiscal Year
GnRH	Gonadotropin-releasing Hormone
MDAC	Mississippi Department of Agriculture and Commerce
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
NAM	Nalbuphine HCL, Medetomidine HCL, and Azaperone tartrate
NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
PL	Public Law
T&E	Threatened and Endangered
TVA	Tennessee Valley Authority
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Services
WS	Wildlife Services

EXECUTIVE SUMMARY

Wildlife are an important public resource that can provide economic, recreational, emotional, and esthetic benefits to many people. However, wildlife can cause damage to agricultural resources, natural resources, property, and threaten human safety. When people experience damage caused by wildlife or when wildlife threatens to cause damage, people may seek assistance from other entities. The United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) program is the lead federal agency responsible for managing conflicts between people and wildlife. Therefore, people experiencing damage or threats of damage associated with wildlife could seek assistance from WS. In Mississippi, WS has and continues to receive requests for assistance to reduce and prevent damage associated with several mammal species.

The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental planning into federal agency actions and decision-making processes. Therefore, if WS provided assistance by conducting activities to manage damage caused by mammal species, those activities would be a federal action requiring compliance with the NEPA. The NEPA requires federal agencies to have available and fully consider detailed information regarding environmental effects of federal actions and to make information regarding environmental effects available to interested persons and agencies. To comply with the NEPA, WS, in cooperation with the Tennessee Valley Authority (TVA) prepared this Environmental Assessment (EA) to determine whether the potential environmental effects caused by alternative approaches to managing damage caused by several mammal species might be significant, requiring the preparation of an Environmental Impact Statement (EIS).

Chapter 1 of this EA discusses the need for action and the scope of analysis associated with requests for assistance that WS receives involving several mammal species in Mississippi. Chapter 2 identifies and discusses the issues that WS and the TVA identified during the scoping process for this EA and through consultation with federal, tribal, and state agencies. Issues are concerns regarding potential effects that might occur from proposed activities. Federal agencies must consider such issues during the decision-making process required by the NEPA. Chapter 2 also discusses the alternative approaches that WS and the TVA developed to meet the need for action and to address the issues identified during the scoping process.

Issues of concern addressed in detail include: 1) effects on target mammal populations, 2) effects on non-target species, including threatened and endangered species, 3) effects of management methods on human health and safety, and 4) humaneness and animal welfare concerns of methods. Alternative approaches evaluated to meet the need for action and to address the issues include: 1) continuing the current integrated methods approach to managing damage, 2) using an integrated methods approach using only non-lethal methods, 3) addressing requests for assistance through technical assistance only, and 4) no involvement by WS. Depending on the alternative approach, several methods would be available to manage damage caused by mammal species. Appendix C discusses the methods that WS could consider when responding to a request for assistance.

Chapter 3 provides information needed for making informed decisions by comparing the environmental consequences of the four alternative approaches to determine the extent of actual or potential impacts to each of the issues. WS and the TVA will use the analyses in this EA to help inform agency decision-makers on the significance of the environmental effects, which will aid in determining the need to prepare an EIS or concluding the EA process with a Finding of No Significant Impact.

CHAPTER 1: NEED FOR ACTION AND SCOPE OF ANALYSIS

1.1 INTRODUCTION

Wildlife is an important public resource people greatly value. In general, people regard wildlife as providing economic, recreational, emotional, and esthetic benefits. For many people, simply knowing that wildlife exist in the natural environment provides a positive benefit. Wildlife can also be important to the culture and beliefs of Native American Tribes. However, the behavior of animals may result in damage to agricultural resources, natural resources, and property, and threaten human safety. Wildlife damage management is the alleviation of damage or other problems caused by or related to the behavior of wildlife and can be an integral component of wildlife management (Berryman 1991, Reidinger and Miller 2013, The Wildlife Society 2017) and the North American Model of Wildlife Conservation (Organ et al. 2010, Organ et al. 2012). People experiencing damage or the threat of damage caused by animals often seek assistance with managing the damage or threat of damage.

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program is the lead federal agency responsible for managing conflicts between people and wildlife (USDA 2019*a*) (see WS Directive 1.201)[1]. The primary statutory authority for the WS program is the Act of March 2, 1931 (46 Stat. 1468; 7 USC 8351-8352) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 8353). WS' directives define program objectives and guide WS' activities when managing wildlife damage (see WS Directive 1.201, WS Directive 1.205, WS Directive 1.210).

In Mississippi, WS has and continues to receive requests for assistance to reduce and prevent damage associated with several species of mammals. The National Environmental Policy Act (NEPA) requires federal agencies to incorporate environmental planning into federal agency actions and decision-making processes. To comply with the NEPA, WS prepared this Environmental Assessment (EA) in cooperation with the Tennessee Valley Authority (TVA) to determine whether the potential environmental effects caused by alternative approaches to managing damage caused by mammal species might be significant, requiring the preparation of an Environmental Impact Statement (EIS). The TVA may request assistance from WS to manage wildlife damage on property they own or manage in Mississippi.

This EA will assist in determining if the proposed action could have a significant impact on the human environment based on previous activities conducted by WS and based on the anticipation of conducting additional efforts to manage damage caused by those species, including activities that could occur on property owned or managed by the TVA. In 2015, WS developed an EA in cooperation with the TVA that analyzed the need for action to manage damage associated with several mammal species in Mississippi. The 2015 EA identified the issues associated with managing damage associated with several mammal species in the state and analyzed alternative approaches to meet the specific need identified in the EA while addressing the identified issues. Because this EA will re-evaluate activities conducted under the 2015 EA, the outcome of the

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

Decision issued based on the analyses in this EA will supersede the previous EA that addressed several mammal species.

In 2015, WS developed an EIS to review the environmental impacts of alternative approaches to achieve the APHIS' goal of reducing damage caused by feral swine to agriculture, natural and cultural resources; property; animal health; and human health and safety (USDA 2015). The EIS analyzed alternative approaches that are programmatic in nature. The EIS guides APHIS cooperation and interactions with program partners and provides a system for allocation of project resources. 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. However, the EIS did not replace the need to develop state, territorial, or local level analyses to address local issues and needs in accordance with the Council on Environmental Quality and APHIS' implementing regulations under the NEPA. Therefore, this EA will evaluate the need for action, issues, and alternative approaches to reducing feral swine damage or threats of damage throughout the State of Mississippi. In accordance with the Record of Decision, WS developed this EA to be consistent with the EIS and the Record of Decision.

The TVA developed an extensive Natural Resources Plan to strategically evaluate both renewable and nonrenewable resources and fulfill the responsibilities associated with good stewardship of TVA lands and resources. The Natural Resources Plan includes ten focus areas that encompass TVA's work in resource stewardship. The newest focus areas added to the plan include Section 26a Permitting and Land Use Agreements, Nuisance and Invasive Species Management, and Ecotourism (TVA 2020*a*).

The TVA also prepared an EIS to assess the impacts of the Natural Resource Plan and its reasonable alternatives on the environment. The TVA EIS specifically describes the stewardship programs that are ongoing, the programs the TVA is evaluating for future implementation as part of the Natural Resource Plan, and assesses the potential environmental impacts associated with implementing the various alternatives. With the release of an updated Natural Resource Plan, the TVA completed a supplemental EIS to assess and analyze potential impacts associated with the proposed changes in the updated Natural Resource Plan (TVA 2011, TVA 2020*b*).

1.2 NEED FOR ACTION

Some species of animals have adapted to and have thrived in human altered habitats. Those species, in particular, are often responsible for the majority of conflicts between people and animals. Those conflicts often lead people to request assistance with reducing damage to resources and to reduce threats to human safety. People may request assistance from WS to alleviate damage and threats of damage caused by animals. Therefore, the need for action arises from requests for assistance[2] that WS could receive to reduce and prevent damage from occurring. WS has identified those mammal species most likely to be responsible for causing damage in Mississippi based on previous requests for assistance and in anticipation of receiving requests for assistance in the future.

[2]WS would only conduct damage management after receiving a request for assistance. Before initiating damage management activities, WS and the cooperating entity must sign a Memorandum of Understanding, work initiation document, or another comparable document that lists all the methods the property owner or manager would allow WS to use on property they own and/or manage.

Those mammal species include nine-banded armadillos (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginiana*), southeastern myotis (*Myotis austroripariuis*), Brazilian free-tailed bats (*Tadarida brasiliensis*), silver-haired bats (*Lasionycteris noctivagans*), big brown bats (*Eptesicus fuscus*), evening bats (*Nycticeius humeralis*), Rafinesque's big-eared bats (*Corynorhinus rafinesquei*), Eastern cottontail (*Sylvilagus floridanus*), swamp rabbits (*Sylvilagus aquaticus*), American black bears (*Ursus americanus*), raccoons (*Procyon lotor*), North American river otters (*Lontra canadensis*), striped skunks (*Mephitis mephitis*), coyotes (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), bobcats (*Lynx rufus*), woodchucks (*Marmota monax*), Southern flying squirrels (*Glaucomys volans*), eastern grey squirrels (*Sciurus carolinensis*), fox squirrels (*Sciurus niger*), feral swine (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), feral cats (*Felis domesticus*), and feral dogs (*Canis familiaris*). Collectively, this EA will refer to those species as mammals unless otherwise indicated.

In addition, WS could occasionally receive requests for assistance to manage damage and threats of damage caused by feral or free-ranging non-native mammals[3]. WS also receives requests for assistance to manage damage and threats of damage associated with beaver (*Castor canadensis*), muskrats (*Ondatra zibethicus*), and nutria (*Myocastor coypus*) (collectively referred to as aquatic rodents) in Mississippi; however, activities associated with aquatic rodents are addressed in a separate EA.

The Tennessee Valley Authority (TVA) also continues to experience damage and threats of damage associated with mammals at facilities or properties they own or manage in Mississippi. The TVA could request the assistance of WS to manage damage or threats of damage at those facilities and properties.

The need for action to manage damage and threats associated with mammals in Mississippi arises from requests for assistance[4] received by WS. WS receives requests to reduce or prevent damage from occurring to four major categories: agricultural resources, natural resources, property, and threats to human safety. In addition, the TVA often experiences damage and threats of damage to property and natural resources, electric system operational reliability, as well as threats to human safety at their facilities. WS and the TVA have identified those mammal species most likely to be responsible for causing damage to those four categories in the state based on previous requests for assistance.

Table 1.1 lists mammal species addressed in this EA and resource types that those mammal species can damage in Mississippi. Many of the species can cause damage to or pose threats to multiple resource types. In Mississippi, most requests for assistance received by WS relate to mammal species causing damage or posing threats of damage to property, agriculture, and human safety. WS also receives requests to collect disease samples from those species identified in Table 1.1.

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[3]See further discussion for the proposed action/no action alternative (Alternative 1) in Section 3.1.1

[4]WS would only conduct mammal damage management after receiving a request for assistance. Before initiating damage management activities, WS and the cooperating entity would sign a Memorandum of Understanding, work initiation document, or other comparable document that would list all the methods the property owner or manager would allow WS to use on property they owned and/or managed.

Table 1.1 – Mammal species that WS could address in Mississippi and the resource types those species are likely to damage in Mississippi

Species	Resource[a] A	N	P	H	Species	Resource A	N	P	H
Bat (All species)			X	X	**Nine-banded Armadillo**	X	X	X	X
Black Bear	X		X	X	**Raccoon**	X	X	X	X
Bobcat	X	X	X	X	**Red Fox**	X	X	X	X
Coyote	X	X	X	X	**River Otter**	X		X	
Eastern Cottontail	X		X		**Southern Flying Squirrel**			X	
Feral Cat	X	X	X	X	**Striped Skunk**	X	X	X	X
Feral Dog	X	X	X	X	**Swamp Rabbit**	X		X	
Feral Swine	X	X	X	X	**Virginia Opossum**	X	X	X	X
Fox Squirrel			X		**White-tailed Deer**	X	X	X	X
Gray Fox	X	X	X	X	**Woodchuck**	X		X	
Eastern Gray Squirrel			X						

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

All of the species addressed in this EA can cause damage to property, including posing strike risks at airports and airbases in Mississippi or posing as attractants for other species that are strike risks. For example, high densities of cottontail rabbits at an air facility may attract raptors to the area and those raptors may pose strike risks to aircraft. Nearly all of these species can pose threats to agricultural resources or cause damage to those resources. For example, predatory mammals (*e.g.*, coyotes, bobcats, fox, and raccoons) may kill livestock. Raccoons may enter storage facilities to feed on stored animal feed and contaminate the feed with their feces.

More specific information regarding mammal damage to those main categories, including damage or threats that could occur on properties owned or managed by the TVA, are discussed below in Subsection 1.2.1 through Subsection 1.2.6 of the EA.

1.2.1 Need for Mammal Damage Management on TVA Properties and Facilities

The TVA often experiences damage or threats of damage to property and natural resources, electric system operational reliability, as well as threats to human safety at their facilities. The TVA is responsible for the management of 293,000 acres of public land and 11,000 miles of public shoreline along the Tennessee River system. All of those lands support TVA's goals of power generation and transmission, public recreational use, flood control, and economic development of the Tennessee River Valley. The TVA owns or maintains electrical power substations, switching stations, and the associated transmission lines and rights-of-way easements in Mississippi. In addition, the TVA operates public recreation areas throughout the Tennessee River Valley region, including campgrounds, day-use areas, and boat launching ramps.

Mammal damage and threats of damage at facilities and properties owned or managed by the TVA have primarily occurred to property, human safety, and impacts on the reliability of transmitting electricity to customers. Woodchucks and armadillos burrowing into earthen levees and dikes used to impound water can compromise the integrity of the structures and threaten the safety of people downstream from these impoundments.

Many species of wildlife reside on TVA-managed lands. Those animals frequently become overpopulated or lose their fear of people, sometimes resulting in transmission of zoonotic diseases and aggressive behavior toward people. Many of those lands are considered public or recreational lands and those people using those lands expect the TVA to manage mammal populations and reduce the possibilities of disease transmission and attacks by wildlife. Mammals frequently enter substations and power generation facilities and threaten to interrupt power by chewing on various plastic components or climbing into areas of electric current and shorting out electrical circuits.

Those damage issues and others occur throughout TVA owned and managed properties. The TVA has requested assistance from WS to address wildlife damage in the past and may request assistance with additional mammal damage in the future. As the populations of many of those species increase and thrive in areas managed or owned by the TVA, both WS and TVA expect increases in the need for mammal damage management in the future.

1.2.2 Need to Alleviate Damage to Agricultural Resources

Armadillos, opossum, bears, raccoons, otters, skunks, coyotes, fox, bobcats, woodchucks, feral swine, deer, feral cats, and feral dogs can cause losses or injury to crops (*e.g.*, corn), livestock (*e.g.*, sheep, goats, cattle, pigs, horses), and poultry (*e.g.*, chickens, turkeys, geese, ducks) through consumption or predation. During 2001, crop and livestock losses from animals in the United States totaled \$944 million, with field crop losses totaling \$619 million, livestock and poultry losses totaling \$178 million, and losses of vegetables, fruits, and nuts totaling \$146 million. Those losses include destruction of or damage to crops in the field and death or injury to livestock. In 2001, the National Agricultural Statistics Service (NASS) reported that raccoons were responsible for 6%, 3%, and 6% of the total damage to field crops; livestock and poultry; and vegetables, fruits, and nuts, respectively, in the United States (NASS 2002). In addition, white-tailed deer accounted for 58% of the total field crop damage and 33% of vegetable, fruit, and nut damage. Feral swine accounted for 3% or \$18.5 million in damages to field crops (NASS 2002). Annual damage and cost of feral swine control is estimated at \$1.5 billion in the United States (Glow et al. 2020).

In 2015, the NASS (2017) reported cattle and calf losses from animal predation totaled 280,570 head in the United States according to livestock producers. In Mississippi, the NASS (2017) reported animal predators killed 210 cattle and 5,060 calves during 2015. Animal predators in Mississippi caused an estimated \$5.3 million in economic losses during 2015. Coyotes caused 10.1% of the cattle losses and 53.6% of the calves lost in Mississippi while dogs caused 15.5% of the cattle losses and 5.9% of calf losses. Livestock producers in Mississippi also reported livestock losses associated with black bears and bobcats. Predators can also prey on other livestock, such as chickens, sheep, goats, and swine.

Many of the requests for assistance WS receives involving agricultural resources are associated with feral swine. Agricultural damage and threats caused by feral swine can occur to a variety of crops, livestock, pastures, hayfields, water sources, livestock feed, and other agricultural resources (Beach 1993, Seward et al. 2004, West et al. 2009, Stevens 2010, Hamrick et al. 2011). Damage occurs from direct consumption of agricultural resources and from trampling, rooting, and/or wallowing that are common activities of feral swine (Beach 1993). Rooting is a common activity of feral swine where they overturn sod and soil in search of food (Mayer and Brisbin 2009, West et al. 2009, Stevens 2010, Hamrick et al. 2011). Feral swine also wallow in water and mud to regulate body temperature and to ward off skin parasites. Wallowing and rooting activities in watering areas for livestock can result in severely muddied water, algal blooms, oxygen depletion, bank erosion, and reduction in fish viability (Beach 1993). Since feral swine often travel in family groups, damage from rooting and wallowing can be extensive often encompassing several acres.

In addition, feral swine could transmit diseases to domestic livestock. Feral swine can act as reservoirs for several diseases that are known to be transmissible between feral swine and domestic livestock, including African swine fever, pseudorabies, brucellosis, leptospirosis, porcine parvovirus, swine influenza, and porcine reproductive and respiratory syndrome virus (Wood and Barrett 1979, Corn et al. 1986, Beach 1993, Saliki et al. 1998, Witmer et al. 2003, Davidson 2006, USDA 2009, Wyckoff et al. 2009). Disease transmission is likely to occur where domestic livestock and feral swine have a common interface, such as at water sources and livestock feeding areas.

Although several diseases carried by swine are also transmissible to other livestock, the primary concern is the potential transmission of diseases from feral swine to domestic swine. Many of the diseases associated with feral swine also negatively affect the health and marketability of domestic swine that can lead to economic losses to the livestock producer. A disease outbreak not only has negative economic implications to the individual livestock producer, but an outbreak also could cause economic losses that can negatively affect the statewide swine industry.

Woodchucks (commonly referred to as groundhogs) can cause damage to field crops, such as row and forage crops, orchards, nursery plants, and commercial gardens. Cottontail rabbits can damage orchard trees by gnawing at the base of the tree. Trees can be badly damaged when the bark is girdled, which may occur when feeding by rabbits is severe. Similar damage can occur in nurseries that grow landscape ornamentals and shrubs. River otters and, to a lesser extent, bears and raccoons, may prey on fish and other cultured species at hatcheries and aquaculture facilities (Bevan et al. 2002). River otters may even prey on fish in marine aquaculture facilities (Goldburg et al. 2001).

1.2.3 Need to Protect Human Health and Safety

Zoonoses (*i.e.*, wildlife diseases transmissible to people) can be a concern of people requesting assistance from WS. Disease transmission could occur from direct interactions between people and animals or from interactions with pets and livestock that have direct contact with wild animals. Pets and livestock can encounter and interact with wildlife, which can increase the opportunity of transmission of disease to people. There are several viral, bacterial, mycotic (fungal), protozoal, and rickettsial pathogens that mammals can transmit to people (*e.g.*, see Beran 1994, Davidson 2006). Hunters have contracted brucellosis or trichinosis after coming into contact with infected feral swine without gloves or consuming undercooked meat (Glow et al. 2020). However, actual transmission of diseases to people is thought to be rare.

The most common disease concern expressed by individuals requesting assistance is the threat of rabies transmission to people, pets, and companion animals. Rabies is an acute, fatal viral disease of mammals most often transmitted through the bite of a rabid animal that poses an indirect and direct threat to people. Indirect threats to people occur from exposure from pets or livestock that have been infected from bites of a rabid animal. Direct threats can occur from handling infected wildlife or from aggressive animal behavior caused by rabies. The disease can be effectively prevented in people when exposure is identified early and treated. In addition, domestic animals and pets can be vaccinated for rabies.

Most incidents of rabies currently occurring in the state are associated with bats (Mississippi State Department of Health 2018). Conflicts involving bats can include property damage but can also involve threats to the health of people, pets, and livestock. The buildup of bat droppings and urine in attics and between walls can result in odor problems and discoloration of walls and ceilings (Greenhall and Frantz 1994). In addition to the threat of rabies from direct contact or a bat entering the living area of a home, there are other threats associated with bat colonies, including histoplasmosis, fungal spores, and mites (Greenhall and Frantz 1994, Jones and Jordan 2004).

From federal fiscal year (FY) 2019 through FY 2023, WS has received requests for assistance to manage threats to human health and safety in Mississippi associated with coyotes, bats, raccoons, striped skunks, feral swine, bobcats, red fox, gray fox, Eastern gray squirrels, white-tailed deer, and Virginia opossum.

WS actively attempts to educate the public about the risks associated with disease transmission from animals to people through technical assistance and by providing technical leaflets on the risks of exposure.

1.2.4 Need to Respond to Emergency Efforts

In the event of large-scale natural disasters (*e.g.*, hurricanes, tornadoes, floods) and small-scale localized emergencies (*e.g.*, release of exotic animals, traffic accidents involving animal transport vehicles) federal, state, and local governments may request WS' assistance. Such requests for assistance would be on extremely short notice and rare emergencies that would be coordinated by federal, state, and local emergency management agencies. For example, in order to prevent a highway emergency, WS' personnel may receive requests to participate in the removal of cattle that were injured or were released from their transport vehicle at the scene of an accident. WS could receive requests to corral those animals that were uninjured and euthanize those animals that have been injured to reduce their suffering. In another example, WS' personnel may receive requests to assist local and state law enforcement in immobilization or lethal control of exotic animals that have been accidentally released in the aftermath of a hurricane or tornado.

1.2.5 Need for Mammal Damage Management to Alleviate Property Damage

All of the mammal species identified in Section 1.2 can cause damage to property (see Table 1.1). Mammals cause damage to a variety of property types in Mississippi each year primarily through direct damage to structures. Some examples of direct damage to property are Eastern gray squirrels gnawing on the wiring of vehicles and accumulations of fecal droppings from bats roosting in an attic that can cause damage to buildings and other structures such as insulation and support structures. Aircraft striking mammals can also cause substantial damage requiring costly repairs and aircraft downtime. Raccoons, skunks, woodchucks, and armadillos can cause damage to property by digging under porches, buildings, homes, and many other places. Armadillos often cause damage to lawns and turf while digging for grubs and insects.

The civil and military aviation communities have acknowledged that the threat to human health and safety from aircraft collisions with wildlife is increasing (Dolbeer 2000, MacKinnon et al. 2004, Dolbeer 2009, Dolbeer et al. 2024). Collisions between aircraft and wildlife are a concern throughout the world because wildlife strikes threaten passenger safety (Thorpe 1996), result in lost revenue, and repairs to aircraft can be costly (Linnell et al. 1996, Robinson 1996, Thorpe 1997, Keirn et al. 2010). Aircraft collisions with wildlife can also erode public confidence in the air transport industry as a whole (Conover et al. 1995). Since 1990, the Federal Aviation Administration (2024) has received reports of aircraft striking bats, opossum, coyotes, swine, deer, and a dog at airports in Mississippi.

Feral swine can damage landscaping, wastewater treatment facilities, water impoundments, trees, golf courses, roads, drainage ditches, and cause erosion by feeding in those areas. Feral swine dig or root in the ground with their nose in search of desired roots, grubs, earthworms, and other food sources. The rooting and digging activity of feral swine turns sod and grass over, which often leaves the area bare of vegetation and susceptible to erosion. Feral swine can also pose a threat to property when motor vehicles and aircraft strike swine. Mayer and Johns (2007) collected data on 179 feral swine-vehicle collisions involving 212 feral swine. Mayer and Johns (2007) suggested that vehicular accidents with feral swine are costly due to their mass; and that potentially, the total annual cost of feral swine-vehicle collisions in the United States can be as high as $36 million, roughly $1,173 per vehicle (Mayer and Johns 2007).

Deer browsing can damage and destroy landscaping and ornamental trees, shrubs, and flowers. Developing rural areas into residential areas could enhance deer habitat in those areas. Fertilized lawns, gardens, and landscape plants in those residential areas may serve as high quality sources of food for deer (Swihart et al. 1995). Furthermore, deer are prolific and adaptable, which are characteristics that allow them to exploit and prosper in suitable habitat near urban areas, including residential areas (Jones and Witham 1990). The succulent nature of many ornamental landscape plants, coupled with high nutrient contents from fertilizers, offers an attractive food. In addition to browsing pressure, male deer can damage ornamental trees and shrubs from antler rubbing, which can result in broken limbs and bark removal. While large trees may survive antler-rubbing damage, smaller trees often die, or they become scarred to the point that they are not esthetically acceptable for landscaping.

Armadillos will dig out shelters and dig while rooting out invertebrates in the soil and leaf litter. This digging and rooting behavior are the most common complaints from resource owners in Mississippi. Sandy soils are conducive to digging and armadillos can be found in those areas in Mississippi where sandy soils are present. Similarly, woodchucks can cause extensive damage by burrowing and denning in earthen levees and other mounds. Burrowing activities can threaten the integrity of the earthen embankments. In addition, burrows can be esthetically displeasing to the public and can damage mowing equipment.

1.2.6 Need to Resolve Damage Occurring to Natural Resources

As shown in Table 1.1, many mammal species can cause damage to natural resources in Mississippi. Natural resources include those assets belonging to the public and often managed and held in trust by government agencies as representatives of the people. Such resources may be plants or animals, including threatened and endangered (T&E) species, or habitats in general. Predators often play critical roles in the composition and function of wildlife populations in ecosystems (Witmer et al. 1996). Normally, predation by native predators is part of the function of a healthy ecosystem.

However, many changes have occurred in ecosystems, which have disrupted natural predator-prey relationships, including habitat fragmentation, landscape alteration, and environmental contamination. Human actions are the primary cause of many the changes occurring to ecosystems. Those human-induced changes can negatively affect the viability of some native wildlife populations. Predation may compound declines in native populations that are primarily associated with habitat loss and fragmentation (Cote and Sutherland 1997), especially when predator densities are high or when predators gain access to areas not historically occupied (Stoudt 1982, Bailey 1993).

McDonough et al. (2022) provides a review of the many adverse effects that feral swine can have on ecosystems. Feral swine compete with over 100 species of native wildlife for important and limited natural food supplies. Some species including quail, turkey, endangered sea turtles, and shorebirds are at risk of predation by nest destruction and the consuming of eggs. Feral swine cause damage to natural areas, such as parks, wildlife management areas, wetlands (Bratton 1975, Singer et al. 1982, DeBenedetti 1986, Choquenot et al. 1996, Kaller and Kelso 2003, Kaller and Kelso 2006, Chavarria et al. 2007, Engeman et al. 2007, Mersinger and Silvy 2007, Doupe et al. 2010, USDA 2015, McDonough et al. 2022). Damaged sites suffer erosion and local loss of critical ground plants and roots, as well as destruction of seedlings because of feral swine feeding and rooting (Barrett and Birmingham 1994). Across the United States, feral swine have been found to co-occur with up to 87.2% of imperiled species that are susceptible to impacts from feral swine (McClure et al. 2018). Feral swine may negatively impact species designated by the USFWS as threatened or endangered in Mississippi, such as the eastern black rail (*Laterallus jamaicensis* spp. *jamaicensis*) (USFWS 2019), the threatened gopher tortoises (USFWS 2021), and the endangered Louisiana quillwort (*Isoetes louisianensis*) (USFWS 2024). From FY 2019 through FY 2023, WS has received requests for assistance involving the threat of damage to threatened gopher tortoises associated with feral swine.

Predation can compound declines in bird populations when those declines are associated with habitat loss and fragmentation (Cote and Sutherland 1997). The effects of predation on birds can be detrimental to local populations; especially, when predator densities are high or when predators gain access to areas not historically occupied (Stoudt 1982, Bailey 1993). In general, ground-nesting birds suffer the highest predation rates (DeVos and Smith 1995). For example, Massey (1971) and Massey and Atwood (1981) found that predators can prevent federally endangered least terns (*Sterna antillarum*) from nesting or cause them to abandon previously occupied sites. In another study, predators adversely affected the nesting success of least terns on sandbars and sandpits (Kirsch 1996).

Raccoons, coyotes, skunks, feral swine, fox, and armadillos can predate the eggs and hatchlings of sea turtles, as well as adult sea turtles. Predators can also expose turtle nests to the elements and predation by crabs, birds, and other mammals. Several species of sea turtles could nest along the beaches of the state, including loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), leatherbacks (*Dermochelys coriacea*), and Kemp's Ridley (*Lepidochelys kempii*) sea turtles. The recovery plan for the loggerhead sea turtle lists the following recovery goal: "*Reduce the annual rate of mammalian predation to at or below 10% of nests….using ecologically sound predator control programs*". In addition, the recovery plan states, "*individual problem animals can be targeted and removed without negatively affecting the local populations of native species*" (National Marine Fisheries Service and United States Fish and Wildlife Service 2008). Several studies have documented the effectiveness of predator management in turtle nesting areas (*e.g*., see Garmestani and Percival 2005, Engeman et al. 2010). WS could receive requests for assistance to reduce predation risks in order to meet predation tolerances listed in the recovery plan for sea turtles.

1.2.7 Need to Conduct Disease Monitoring and Surveillance

WS could also receive requests to monitor and conduct surveillance for diseases that may be of concern to agricultural resources, natural resources, and human health and safety because mammals may act as reservoirs for diseases of concern. Requests could involve collecting samples from mammals that WS has captured or lethally removed to alleviate damage or threats of damage. WS could also intentionally capture or lethally remove target mammal species to collect samples for disease testing. In addition, WS could collect samples from mammal species that people have harvested during annual trapping or hunting seasons, were killed by vehicle strikes, and/or died from mortality events. WS could collect samples from mammal species in a variety of ways, including collecting tissue samples, blood samples, and the use of swabs.

1.3 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

WS' mission is to provide federal leadership with managing damage and threats of damage associated with animals (see WS Directive 1.201). WS would only provide assistance when a property owner or manager requested WS' assistance and only on property the requester owns or manages.

1.3.1 Geographic Scope

Many of the mammal species addressed in this EA occur statewide and throughout the year in Mississippi; therefore, damage or threats of damage could occur wherever those mammals occur. WS could receive a request for assistance from a property owner or manager to conduct activities on property they own or manage, which could include federal, state, tribal, municipal, and private land within the State of Mississippi.

1.3.2 Site Specificity

WS would only conduct damage management activities when requested by the appropriate resource owner or manager. This EA analyzes the potential impacts of mammal damage management based on previous activities conducted on private and public lands in Mississippi where WS and the appropriate entities entered into a work initiation document or another comparable document. This EA also addresses the potential impacts of managing damage caused by mammals in areas where WS and a requesting entity could sign additional work initiation documents or similar documents in the future. Because the need for action would be to reduce damage and because the program's goals and directives would be to provide assistance when requested, within the constraints of available funding and workforce, it is conceivable that additional damage management efforts could occur. Thus, this EA anticipates a range of additional efforts and analyzes the potential effects of those efforts as part of the alternative approaches.

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

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

The analyses in this EA apply to any action that may occur by WS in any locale and at any time within Mississippi. In this way, WS and the TVA believes the two agencies meet the intent of the NEPA with regard to site-specific analysis and that this is the only practical way for WS and the TVA to comply with the NEPA and still be able to accomplish their missions. In addition, WS and the TVA will provide for a minimum of a 30-day comment period for the public and interested parties to provide new issues, concerns, and/or alternative approaches. Through the public involvement process, WS and the TVA will clearly communicate to the public and interested parties the analyses of potential environmental impacts on the quality of the human environment. WS and the TVA will fully consider new issues, concerns, or alternative approaches the public identifies during the public involvement period to determine whether WS and the TVA should revisit the EA and, if appropriate, revise the EA prior to issuance of a Decision.

1.4 PARTNER AGENCY ROLES AND AUTHORITIES

Below are brief descriptions of the roles and authorities of other federal, tribal, and state agencies, as those authorities relate to conducting wildlife damage management.

1.4.1 Tennessee Valley Authority

The TVA is a federal corporation created by an Act of Congress on May 18, 1933 [48 Stat. 58-59, 16 USC Sec. 831, as amended]. The TVA provides electricity to 9 million people, businesses and industries, and manages 293,000 acres of public land and 11,000 miles of reservoir shoreline in the Tennessee Valley Region, including Mississippi. The TVA also provides flood control, navigation, land management, and recreation for the Tennessee River system and works with local utilities and state and local governments to promote economic development across the region.

In Mississippi, the TVA generates electricity at three combustion turbine sites and two solar facilities. The electricity TVA generates is transmitted over 16,000 miles of transmission line across the Valley. TVA also owns or maintains 80 substations and 2,037 circuit miles of transmission lines in Mississippi. The TVA conducts and requests assistance from WS to provide wildlife damage management on land and at facilities owned by the TVA. The TVA also makes its public lands available for use for continuation and expansion of the WS' Oral Rabies Vaccine program across the states within the Tennessee River Basin and Valley.

1.4.2 Mississippi Department of Wildlife, Fisheries, and Parks

The Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) authority in wildlife management is given within the Mississippi Code Annotated Section 49-1-1 et seq., the official regulations of the Commission of Wildlife, Fisheries and Parks and applicable federal laws. This legislation covers general provisions; licenses, permits and stamps; wildlife; fish; and wild animals.

The MDWFP has developed an extensive State Wildlife Action Plan that evaluates all species of plant and animal known to exist within the state. The primary goal of the Mississippi State Wildlife Action

Plan is "…*to provide a guide to effective and efficient long-term conservation of Mississippi's biological diversity*" (Mississippi Museum of Natural Science 2015).

1.4.3 Mississippi Department of Agriculture and Commerce

The Pesticide Program of the Mississippi Department of Agriculture and Commerce (MDAC) enforces state laws pertaining to the use and application of pesticides. Under the Mississippi Pesticide Application Act (Sections 69-23-101 through 69-23-133) this program monitors the use of pesticides in a variety of pest management situations. It also licenses private and commercial pesticide applicators and pesticide contractors. Under the Mississippi Pesticide Law (Section 69-23-1 through 69-23-27) the program licenses restricted use pesticide dealers and registers all pesticides for sale and distribution in the state of Mississippi.

1.5 How does WS-Mississippi comply with NEPA?

The APHIS-WS program follows USDA NEPA Implementing Procedures as part of the decision-making process. This Final EA and the corresponding FONSI Decision Document were completed within the one-year EA timeline.

1.5.1 How does NEPA apply to WS-Mississippi's MDM activities

NEPA sets forth the requirement that all federal actions be evaluated in terms of:

- Their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts;
- Making informed decisions; and
- Including agencies and the public in their NEPA planning in support of informed decision-making.

The analyses contained in this environmental assessment (EA) are based on information and data derived from APHIS-WS' Management Information System (MIS) database; data from the MDA, MDWFP, and the USFWS regarding species under their jurisdiction; published and, when available, peer-reviewed scientific documents; interagency consultations; public involvement; and other relevant sources.

This EA describes the needs for resolving mammal damage problems for which WS-Mississippi is typically requested to assist. The EA identifies the potential issues associated with reasonable alternative ways and levels of providing that assistance. It then evaluates the environmental consequences of the alternatives for WS-Mississippi's involvement in MDM.

Public outreach notification methods for this EA included postings on the national APHIS-WS NEPA webpage and on www.regulations.gov, email to known local stakeholders, and electronic notification to registered stakeholders on www.GovDelivery.com. No public comments were received during the public comment period for the Pre-decisional EA, which ended on September 1, 2025. The public will be informed of the decision using the same venues.

CHAPTER 2: ISSUES AND ALTERNATIVS

2.1 INTRODUCTION TO ISSUES AND ALTERNATIVES

WS and the TVA have identified several issues associated with the activities that WS could implement to meet the need for action to manage damage caused by mammals in Mississippi. Issues are concerns regarding potential effects that might occur from proposed activities. Federal agencies must consider such issues during the decision-making process required by the NEPA. Section 2.2 of this EA discusses the issues that WS and the TVA identified, which could occur from implementation of the alternative approaches to meet the need for action. Section 3.2 discusses additional issues that WS and the TVA identified; however, the EA does not analyze those issues in detail for the reasons provided in Section 3.2.

WS and the TVA developed four alternative approaches to meet the need for action that Section 1.2 of this EA identifies and to address the identified issues discussed in Section 2.2. Section 2.5 discusses the four alternative approaches that WS could implement to meet the need for action. Section 2.6 discusses the alternative approaches considered but not analyzed in detail and provides the rationale for not considering those alternative approaches in detail within this EA. In addition, WS directives would provide guidance to WS personnel conducting official activities (see WS Directive 1.101).

2.2 ISSUES USED TO DEVELOP ALTERNATIVES

Conducting activities to address the need for action raises concerns regarding potential effects that might occur from those activities. A common issue when addressing damage caused by animals is the potential impacts of management actions on populations of target and non-target species because activities to alleviate damage could exclude, disperse, capture, or kill animals, which could also affect the recreational opportunities associated with target species. There is also a concern that the impact of activities on the populations of target animals could result in effects on biodiversity and cause a mesopredator release or a trophic cascade. Effects on human health and safety and sociocultural resources associated with conducting activities are an additional concern.

This section describes the issues identified during the scoping process for this EA. Section 3.1 analyzes the environmental consequences of each alternative approach in comparison to determine the extent of actual or potential impacts on the issues. WS and the TVA evaluated, in detail, the following issues.

2.2.1 Effects of Damage Management Activities on Target Mammal Populations

Native mammal species play a vital role in a healthy ecosystem; therefore, a common issue when addressing damage caused by wildlife is the potential impacts of management actions on the populations of mammal species, especially when using lethal methods. Therefore, 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 alleviate damage or threats of damage include both non-lethal and lethal methods. Non-lethal methods available can capture, exclude, disperse, or otherwise make an area unattractive to target species causing damage, which can reduce the presence of those species at the site and potentially the immediate area around the site where people use those non-lethal methods. Lethal methods could also be available to remove an individual or individuals of the target species responsible for causing damage or posing threats to human safety. Therefore, lethal methods could result in local population reductions in the area where damage or threats were occurring, which could cause a species' population to decline depending on the magnitude of the impact.

In addition, some individuals believe their recreational experiences on public lands would be impaired knowing that damage management activities could be occurring on those lands, such as being deprived of the esthetic experience of viewing or hearing mammals because of activities conducted by WS. Most of the land area in Mississippi is privately owned. However, WS could be requested to provide assistance on federal, state, county, and municipal properties within the state. Activities under the alternative approaches would only occur when the appropriate property owner or manager requested assistance from WS.

2.2.2 Effects of Activities on the Populations of Non-target Animals, Including T&E Species

The potential for effects on non-target species, including threatened or endangered species, arises from the use of non-lethal and lethal methods identified in the alternative approaches. The use of non-lethal and lethal methods has the potential to inadvertently exclude, disperse, capture, or kill non-target animals. Appendix C describes the methods available for use under the alternative approaches.

2.2.3 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 employing methods to manage damage caused by target species. WS would use and recommend only those methods that were legally available, selective for target species, and effective at resolving the damage associated with the target species. Still, some concerns exist regarding the safety of methods despite their legality, selectivity, and effectiveness. As a result, this EA will analyze the potential for proposed methods to pose a risk to members of the public and employees of WS. Section 3.1.3 in this EA further evaluates the risks to human safety as this issue relates to the alternative approaches.

2.2.4 Humaneness and Animal Welfare Concerns of Methods

Several non-lethal and lethal methods would be available to alleviate damage associated with target species. The use of non-lethal and lethal methods has the potential to disperse, exclude, capture, or kill animal species. Section 3.1.4 in this EA discusses concerns regarding the humaneness of available methods and animal welfare concerns.

2.3 DAMAGE MANAGEMENT STRATEGIES

The following subsections discuss the damage management strategies, approaches, and decision-making process if WS provides assistance.

2.3.1 Integrated Wildlife Damage Management Strategies

The most effective approach to resolving wildlife damage is to integrate the use of several methods simultaneously or sequentially while continuing to evaluate the effectiveness of the method or methods. An integrated wildlife damage management approach is the implementation and application of safe and practical methods for the prevention and control of damage caused by wildlife based on local problem analyses and the informed judgement of trained personnel. WS applies the integrated wildlife damage management strategy to reduce wildlife damage using the WS Decision Model (see WS Directive 2.201).

The philosophy behind an integrated wildlife damage management strategy is to implement effective management techniques while minimizing the potentially harmful effects to people, target species, non-target species, and the environment. An integrated wildlife damage management approach draws from the largest possible array of options to create a combination of techniques appropriate for the specific circumstances. Integrated wildlife damage management would incorporate appropriate methods depending on the characteristics of the specific request for assistance. When selecting management techniques, consideration is given to the species responsible, the magnitude of the damage, geographic extent of damage, duration and frequency of the damage, and the prevention of future damage. The cost of management may sometimes be a secondary concern because of overriding environmental, legal, human health and safety, animal welfare, or other concerns.

Operational assistance

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

Technical assistance/education and outreach

WS would provide technical assistance to those persons requesting assistance with managing damage as part of an integrated approach. WS could receive requests for assistance from community representatives, private individuals/businesses, or from public entities. Technical assistance would provide those people experiencing damage or threats caused by mammals with information, demonstrations, and recommendations on available and appropriate methods. The implementation of methods and techniques to resolve or prevent damage would be the responsibility of the requester with no direct involvement by WS.

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

Research and development by the National Wildlife Research Center

The National Wildlife Research Center is the research unit of the national WS program. The National Wildlife Research Center provides scientific information and develops methods to address damage caused by animals. Research biologists with the National Wildlife Research Center work closely with WS personnel, wildlife managers, researchers, and others to develop and evaluate methods and techniques to manage wildlife damage. For example, research biologists from the National Wildlife Research Center were involved with developing and evaluating the reproductive inhibitor known under the trade name of GonaCon™. Research biologists with the National Wildlife Research Center have authored hundreds of scientific publications and reports based on research conducted involving wildlife and methods.

2.3.2 Decision model discussion and decision-making

The WS Decision Model (see WS Directive 2.201) described by Slate et al. (1992) depicts how WS' personnel would use a thought process for evaluating and responding to damage complaints. Most efforts to resolve wildlife damage consist of continuous feedback between receiving the request and monitoring the results of the damage management strategy. The Decision Model is not a written documented process, but a mental problem-solving guide common to most, if not all, professions, including WS.

WS Decision Model

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

1. **Receive Request for Assistance:** WS would only provide assistance after receiving a request for such assistance. WS would not respond to public bid notices.
2. **Assess Problem:** First, WS would make a determination as to whether the assistance request is within the authority of WS. If an assistance request is within the authority of WS, WS employees would gather and analyze damage information to determine applicable factors, such as what species are responsible for the damage, the type, extent, and magnitude of damage. Other factors that employees could gather and analyze would include the current economic loss or current threat (*e.g.*, threat to human safety), the potential for future losses or damage, the local history of damage, what management

methods, if any, were used to reduce past damage, and the results of implementing those methods.

3. **Evaluate Management Methods:** Once a problem assessment is completed, a WS employee would conduct an evaluation of available management methods. Appendix C discusses those methods that WS employees would consider when evaluating management methods to alleviate damage or threats of damage associated with mammals. The employee would evaluate available methods in the context of their legal and administrative availability and their acceptability based on biological, environmental, humaneness, social, and cultural factors. When evaluating management methods and formulating a management strategy, WS personnel would give preference to non-lethal methods when they determine those methods to be practical and effective (see WS Directive 2.101).
4. **Formulate Management Strategy:** A WS employee would formulate a management strategy using those methods that the employee determines to be practical for use. A WS employee would also consider factors essential to formulating each management strategy, such as available expertise, legal constraints on available methods, human safety, humaneness, non-target animal risks, costs, and effectiveness.
5. **Provide Assistance:** After formulating a management strategy, a WS employee would provide technical assistance and/or direct operational assistance to the requester (see WS Directive 2.101). All management actions conducted and/or recommended by WS would comply with appropriate federal, state, and local laws in accordance with WS Directive 2.210.
6. **Monitor and Evaluate Results of Management Actions:** When providing direct operational assistance, it is necessary to monitor the results of the management strategy. Monitoring would be important for determining whether further assistance is required or whether the management strategy resolved the request for assistance. Through monitoring, a WS employee would continually evaluate the management strategy to determine whether additional techniques or modification of the strategy is necessary.
7. **End of Project:** When providing technical assistance, a project would normally end after a WS employee provided recommendations or advice to the requester. A direct operational assistance project would normally end when WS personnel stop or reduce the damage or threat to an acceptable level to the requester or to the extent possible. Some damage situations may require continuing or intermittent assistance from WS personnel and may have no well-defined termination point.

2.3.3 Methods Available for Use

Appendix C discusses the methods that would be available for consideration when WS employees formulate a management strategy for each request for assistance using the WS Decision Model. Non-lethal methods would include modifying cultural practices, limited habitat management, supplemental feeding, exclusion methods, visual scaring techniques, paintballs (and similar projectiles), trained dogs, guard animals, nets, hand capture, catch pole, cage-type traps, foothold traps, translocation, unmanned aerial vehicles, aerial operations, scout animals, GonaCon™, immobilizing drugs, repellents, and attractants. Lethal methods would include cable devices, body-grip traps, firearms, euthanasia chemicals, carbon dioxide, and gas cartridges.

2.3.4 Carcass Disposal

WS Directive 2.515 states that all wildlife carcasses, whether in whole or part, will be disposed of consistent with federal, state, county, and local regulations and WS Directive 2.210. Animals euthanized with euthanizing chemicals that may pose secondary hazards to scavengers must be disposed of according to federal, state, county, and local regulations, drug label instructions, or lacking such guidelines, by incineration or at a landfill approved for such disposal. Occasionally, WS could donate meat from white-tailed deer lethally removed during damage management activities to charitable organizations for human consumption (see WS Directive 2.510).

2.4 WS' DIRECTIVES AND PROTECTIVE MEASURES SPECIFIC TO THIS EA

WS' directives define program objectives and guide WS' activities when managing wildlife damage (see WS Directive 1.201, WS Directive 1.205, WS Directive 1.210). WS' personnel would adhere to applicable WS' directives when responding to and providing assistance. WS' directives improve the safety, selectivity, and efficacy of activities that WS' personnel could conduct to alleviate or prevent damage. In addition, WS' personnel would follow the conditions and requirements associated with authorizations provided by the MDWFP or a tribe, including any requirements to report WS' activities. The Memorandum of Understanding between WS and the MDWFP also defines the roles and responsibilities of the agencies as they relate to managing wildlife damage.

Protective measures improve the safety, selectivity, and efficacy of activities intended to resolve wildlife damage. WS would incorporate those protective measures into activities when addressing mammal damage and threats in Mississippi. Some key protective measures pertinent to resolving mammal damage include the following:

- The WS Decision Model would be consistently used and applied when addressing mammal damage.

- WS' personnel would comply with applicable federal, state, tribal, and local laws and regulations in accordance with WS Directive 2.210.

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

- WS' employees would use immobilizing drugs and euthanasia chemicals according to the United States Drug Enforcement Administration, United States Food and Drug Administration, and WS' directives and procedures. WS' employees would follow approved procedures outlined in the WS' Field Manual for the Operational Use of Immobilizing and Euthanizing Drugs (USDA 2019*b*).

- All controlled substances used to immobilize or euthanize target animals would be registered with the United States Drug Enforcement Administration or the United States Food and Drug Administration. WS' employees that use controlled substances would be trained to use each material and would be certified to use controlled substances.

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

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

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

- All WS' personnel who use firearms would receive training according to WS' Directives.

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

Several additional protective measures would be applicable to the alternative approaches and the issues identified in Chapter 2. Section 2.4.1 through Section 2.4.4 below identifies WS' directives and protective measures by each of the issues identified in Section 2.2.

2.4.1 Effects of Damage Management Activities on Target Mammal Populations

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

- WS would report activities to the MDWFP, so the MDWFP has the opportunity to consider the activities conducted by WS. Activities conducted by WS would only occur when authorized by the MDWFP and only at levels authorized.

- WS would conduct damage management activities only when requested by the appropriate property owner or land manager. Activities conducted to alleviate damage or threats of damage would occur in accordance with work initiation documents or other comparable documents signed between WS and the entity requesting assistance.

- WS would direct management actions toward localized populations, individuals, or groups of target species. WS would not conduct generalized population suppression of native wildlife species across Mississippi, or even across major portions of Mississippi.

- WS will monitor activities under the selected alternative approach to ensure activities continue to occur pursuant to the selected alternative. If selecting the no involvement by WS alternative, no monitoring would occur by WS.

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

2.4.2 Effects of Activities on the Populations of Non-target Animals, Including T&E Species

- WS' personnel would strategically place equipment, such as traps and other capture devices, and use lures in a way that they are most likely to capture a target animal and minimize the potential of non-target animal captures. WS' personnel would follow WS Directive 2.450 that establishes guidelines for using certain types of animal capture devices when managing wildlife damage.

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

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

- Any non-target animals captured in cage traps, nets, or any other restraining device would be released whenever it is possible and safe to do so.

- WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. Personnel would directly monitor some live-capture methods (*e.g.*, drops nets, cannon nets, immobilizing drugs administered through a dart gun), which ensures that personnel could release non-target species quickly, if captured. In most cases, WS' personnel would check other live traps (*e.g.*, cage traps, foothold traps, restraining cables), which do not require direct monitoring, at least once every 24 hours or in accordance with Mississippi laws and regulations. Checking traps frequently would help ensure that personnel could release live-captured non-target species in a timely manner.

- Pilots conducting aerial operations would not pursue non-target wildlife and would avoid non-target wildlife whenever possible.

- WS would dispose of mammal carcasses retrieved after WS has conducted damage management activities in accordance with WS Directive 2.515.

- WS has consulted with the USFWS and the MDWFP to evaluate activities to resolve mammal damage and threats to ensure the protection of T&E species. WS would abide by those recommendations made by the USFWS during consultation to ensure activities were not likely to adversely affect T&E species.

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

- WS' personnel would review all projects proposed for implementation for potential to take[5] bald eagles in accordance with the provisions of the Bald and Golden Eagle Protection Act. If WS' personnel identify potential risks of take, WS would work with the USFWS on measures to reduce risks and the need for a non-purposeful take permit.

2.4.3 Effects of Damage Management Activities on Human Health and Safety

- WS' personnel would conduct damage management activities professionally and in the safest manner possible (*e.g.*, early morning).

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

- All chemical methods used by WS or recommended by WS would be registered with the United States Environmental Protection Agency (EPA), the United States Drug Enforcement Administration, the United States Food and Drug Administration, and/or the MDAC, as appropriate.

- WS' personnel will post appropriate warning signs on main entrances or commonly used access points to areas where foothold traps, cable devices, or body-grip traps are in use. WS' personnel would routinely check signs to assure they are present, obvious, and readable.

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

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

- As allowed by law, WS' personnel would provide information about food safety and the safe handling of carcasses to reduce risks to landowners that prefer to retain feral swine

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[5]The Bald and Golden Eagle Protection Act defines "*take*" as "*pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb*." Disturb is defined as any activity that can result in injury to an eagle, or cause nest abandonment or decrease in productivity by impacting breeding, feeding, or sheltering behavior.

carcasses or other animal carcass killed on their property for personal use (see WS Directive 2.510). Therefore, providing information about food safety and the safe handling of carcasses would minimize risks to human safety by emphasizing precautions for safe handling and preparation/consumption. In addition, WS' personnel would advise landowners to avoid feeding uncooked meat or other carcass products to pets or other animals.

2.4.4 Humaneness and Animal Welfare Concerns of Methods

- WS' personnel would receive training in the latest and most humane devices/methods for removing target mammals causing damage.

- WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. Personnel would directly monitor some live-capture methods (*e.g*., drops nets, cannon nets, immobilizing drugs administered through a dart gun), which ensures that personnel can quickly address captured animals. In most cases, WS' personnel would check other live traps (*e.g*., cage traps, foothold traps, restraining cables), which do not require direct monitoring, at least once every 24 hours or in accordance with Mississippi laws and regulations. Checking traps frequently would help ensure that personnel could address animals in a timely manner.

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

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

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

2.5 ALTERNATIVES CONSIDERED IN DETAIL

WS and the TVA developed the following alternative approaches to meet the need for action and address the identified issues associated with managing damage caused by mammals in the state.

2.5.1 Alternative 1 - WS would Continue the Current Integrated Methods Approach to Managing Damage Caused by Mammals in Mississippi (Proposed Action/No Action)

Alternative 1 would continue the current implementation of an adaptive integrated methods approach by WS, when requested, to reduce damage and threats associated with mammal species in Mississippi. WS would continue to provide direct operational assistance and technical assistance. A major goal of the program would be to resolve and prevent damage associated with mammals and to reduce threats to human safety. To meet this goal, WS would continue to respond to requests for assistance with, at a minimum, technical assistance, or when funding was available, operational damage management. Funding could occur through federal appropriations, from state funding, or from cooperative funding. The adaptive approach to managing damage associated with mammals would integrate the use of the most practical and effective methods to resolve a request for assistance as determined by a site-specific evaluation to reduce damage or threats to human safety for each request.

When WS receives a request for direct operational assistance, WS could conduct site visits to assess the damage or threats, identify the cause of the damage, and apply the WS Decision Model described by Slate et al. (1992) and WS Directive 2.201 to determine the appropriate methods to resolve or prevent damage based on the informed judgment of trained personnel. Property owners or managers requesting assistance from WS would be provided with information regarding the use of effective and practical non-lethal and lethal techniques. WS would give preference to non-lethal methods when practical and effective under this alternative approach (see WS Directive 2.101).

WS' Decision Model would be the implementing mechanism for managing mammal damage under the proposed action/no action alternative that could be adapted to an individual damage situation. An adaptive integrated methods approach allows for the largest possible array of options to create a combination of techniques appropriate for the specific circumstances. An integrated methods approach that adapts to each request for assistance may incorporate those lethal and non-lethal methods described in Appendix C. WS would not necessarily use every method from Appendix C to address every request for assistance but would use the WS' Decision Model to determine the most appropriate approach to address each request for assistance. This could include using additional methods from Appendix C if initial efforts were unsuccessful at reducing damage or threats of damage adequately.

2.5.2 Alternative 2 – WS would Manage Mammal Damage Using an Adaptive Integrated Non-lethal Method Approach

Under this alternative, WS would implement only non-lethal methods to resolve damage or threats of damage associated with mammals. Only those methods discussed in Appendix C that are considered non-lethal would be employed or recommended by WS. No intentional lethal removal of mammals would occur by WS. The use of lethal methods to manage damage could continue under this alternative by landowners or resource managers, and by other entities. The non-lethal methods used or recommended by WS under this alternative would be identical to those identified in any of the alternative approaches.

2.5.3 Alternative 3 – WS would Recommend an Integrated Methods Approach to Managing Mammal Damage in Mississippi Through Technical Assistance Only

Under Alternative 3, WS would provide those cooperators requesting assistance with technical assistance only and would not provide any direct operational assistance. Technical assistance would provide those cooperators experiencing damage or threats with information, demonstrations, and recommendations on available and appropriate methods. The implementation of methods and techniques to resolve or prevent damage would be the responsibility of the requester with no direct involvement by WS. WS would recommend an integrated methods approach similar to Alternative 1 when receiving a request for assistance. WS would continue to give preference to non-lethal methods when practical and effective under this alternative (see WS Directive 2.101).

In some cases, WS may provide supplies or materials that were of limited availability for use by private entities (*e.g*., loaning of propane cannons). Technical assistance may be provided through a personal or telephone consultation, or during an on-site visit with the requester. Generally, WS would describe several management strategies to the requester for short and long-term solutions to managing damage. WS would base those strategies on the level of risk, need, and the practicality of their application. WS would use the Decision Model to recommend those methods and techniques available to the requester to manage damage and threats of damage. Those persons receiving technical assistance from WS could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from other entities, or take no further action.

WS would base method and technique recommendations on information provided by the individual(s) seeking assistance using the WS Decision Model. In some instances, wildlife-related information provided to the requester by WS would result in tolerance/acceptance of the situation. In other instances, WS would discuss and recommend damage management options. WS would only recommend or loan those methods legally available for use by the appropriate individual.

Similar to Alternative 1, those methods described in Appendix C would be available to those persons experiencing damage or threats associated with mammals in the state; however, GonaCon™ (deer only), immobilizing drugs, euthanasia chemicals, and the use of aircraft would have limited availability to the public and other entities under this alternative approach. Licensed veterinarians or people under their supervision would be the only entities that could use immobilizing drugs and euthanasia chemicals. The availability of aircraft would also be limited, especially shooting from an aircraft (feral swine and coyotes only). Shooting from an aircraft by entities other than WS to alleviate damage or threats of damage associated with feral swine and coyotes would require authorization from the MDWFP. Under this alternative, the reproductive inhibitor available under the trade name of GonaCon™ would only be available for use by the MDWFP or those persons under the supervision of the MDWFP. At the time this EA was developed, GonaCon™ was not registered for use in the state.

Technical assistance would include collecting information about the species involved, the extent of the damage, and previous methods that the cooperator had attempted to resolve the problem. WS would then provide information on appropriate methods that the cooperator could consider to resolve the damage themselves.

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

2.5.4 Alternative 4 - WS would Not Provide any Assistance with Managing Damage Caused by Mammals in Mississippi

Under this alternative approach, WS would not conduct any activities to manage damage or threats of damage caused by mammals in Mississippi. WS would refer all requests for assistance to resolve damage caused by mammals to the MDWFP, other governmental agencies, and/or private entities. Those persons experiencing damage caused by mammals could continue to resolve damage by employing those methods legally available after authorization by the MDWFP, when required, and during the hunting and/or trapping seasons. People can lethally remove coyotes, fox, skunks, and feral swine at any time when those species are causing damage in accordance with appropriate regulations.

Most of those methods described in Appendix C would be available to those people experiencing damage or threats associated with mammals in the state. GonaCon™ (white-tailed deer only), immobilizing drugs, euthanasia chemicals, and the use of aircraft would have limited availability to the public and other entities under this alternative approach. Licensed veterinarians or people under their supervision would be the only entities that could use immobilizing drugs and euthanasia chemicals. The availability of aircraft would also be limited, especially shooting from an aircraft. Shooting from an aircraft by entities other than WS to alleviate damage or threats of damage would require authorization from the MDWFP. Under this alternative, the reproductive inhibitor available under the trade name of GonaCon™ would only be available for use by the MDWFP or those persons under the supervision of the MDWFP. At the time WS and the TVA developed this EA, GonaCon™ was not registered for use in the state.

2.6 ALTERNATIVE APPROACHES AND STRATEGIES NOT CONSIDERED IN DETAIL

In addition to those alternative approaches analyzed in detail, several additional alternative approaches were identified by WS and the TVA but will not receive detailed analyses. Those alternative approaches considered but not analyzed in detail include:

2.6.1 Implementation of Alternative 1 but WS must use all of the non-lethal methods identified in Appendix C before using lethal methods

Implementation of this alternative approach would be an integrated method approach similar to Alternative 1. However, this alternative approach would require that WS apply non-lethal methods or techniques described in Appendix C to all requests for assistance to reduce damage and threats to safety associated with mammals. If the use of non-lethal methods failed to alleviate the damage situation or reduce threats to human safety at each damage situation, WS would use lethal methods to alleviate the damage or threat occurring. WS would apply non-lethal methods to every request for assistance regardless of severity or intensity of the damage or threat until the employee deemed those non-lethal methods inadequate to resolve the damage or threat. This alternative approach would not prevent the use of lethal methods by other entities to alleviate damage or threats of damage.

People experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting WS (*e.g*., see NASS 2011). If WS implemented this alternative approach, WS would be required to implement non-lethal methods the entity requesting assistance had already used or would have to establish criteria to measure the efforts of the requesting entity to determine if the requesting entity applied non-lethal methods appropriately. Continuing to use methods already proven ineffective at alleviating the damage could prolong the amount of time damage occurs, which could increase economic losses or increase threats to human safety. Because many people that request assistance use non-lethal methods but continue to experience damage or threats of damage and because there is no standard that exists for the use of non-lethal methods, WS did not carry this alternative forward for further analysis in Chapter 3. In addition, implementation of Alternative 1 would be similar to a non-lethal before lethal alternative because WS' personnel would consider the use of non-lethal methods before considering the use of lethal methods (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 this EA.

2.6.2 Use of Non-lethal Methods and Approved Euthanasia Only

Under this alternative approach, WS would continue to employ an integrated methods approach but would only employ non-lethal methods to exclude, haze, or live-capture mammals. When deemed appropriate, WS could continue to remove target mammals using some lethal methods; however, under this alternative, WS would only use methods that captured mammals alive. Once live-captured, WS' personnel would euthanize target animals using methods that meet the definition of euthanasia as defined by the American Veterinary Medical Association (AVMA).

WS would only use euthanasia methods defined by the AVMA (2020) as acceptable or acceptable with conditions, which would include overdoses of injectable anesthetic agents (including barbiturates, such as sodium pentobarbital), potassium chloride, carbon dioxide, and firearms (once live captured). This alternative would be similar to Alternative 1 because WS would give preference to the use of non-lethal methods when practical and effective (see WS Directive 2.101). In addition, WS' personnel would be familiar with the euthanasia methods described by the AVMA and would use those methods to euthanize captured or restrained animals, whenever practicable (see WS Directive 2.430, WS Directive 2.505). Based on the similarity of this alternative approach to the proposed action/no action alternative (Alternative 1), WS did not consider this alternative approach in detail.

2.6.3 Use of Lethal Methods Only by WS

This alternative approach would require the use of lethal methods only to reduce threats and damage associated with mammals. However, non-lethal methods can be effective in preventing damage in certain instances. For example, the use of one-way exclusion devices can be effective with allowing bats to exit a structure but prevent re-entry. Once bats have exited the structure, the owner could complete structural repairs to prevent re-entry of bats. In those situations where damage could be alleviated effectively using non-lethal methods, WS would employ or recommend those methods as determined by the WS Decision Model. Under WS Directive

2.101, WS must consider the use of non-lethal methods before lethal methods. Non-lethal methods have been effective in alleviating mammal damage. Therefore, WS did not consider this alternative in detail.

2.6.4 WS would Develop a Program that Compensates People for Damage

This alternative approach would require WS to establish a system to reimburse persons impacted by mammal damage. Under such an alternative approach, WS would continue to provide technical assistance to those persons seeking assistance with managing damage. In addition, WS would conduct site visits to verify damage. Compensation would require large expenditures of money and labor to investigate and validate damage claims and to determine and administer appropriate compensation. Compensation would most likely be below full market value. Compensation for damages would give little incentive to resource owners to limit damage through improved cultural or other practices and management strategies and would not be practical for reducing threats to human health and safety. For the above listed reasons, WS did not carry this alternative forward for further analysis in Chapter 3.

2.6.5 WS would Establish a Bounty System for Mammal Species

Most wildlife professionals have not supported payment of funds (bounties) for removing animals suspected of causing damage, or posing threats of damage, for many years (Latham 1960). WS concurs because of several inherent drawbacks and inadequacies in the payment of bounties. Bounties are often ineffective at controlling damage over a wide area, such as across the entire District. The circumstances surrounding the removal of animals are typically arbitrary and completely unregulated because it is difficult or impossible to assure animals claimed for bounty were not taken from outside the area where damage was occurring. In addition, WS does not have the authority to establish a bounty program. Therefore, WS and the TVA did not consider this alternative approach in detail.

2.6.6 WS would Implement Alternative 1 but Would Establish a Loss Threshold Before Allowing Lethal Methods

There is also a concern that damage caused by animals should be a cost of doing business and/or that there should be a threshold of damage before allowing the use of lethal methods to manage damage. In some cases, cooperators likely tolerate some damage and economic loss until the damage reaches a threshold where the damage becomes an economic burden. The appropriate level of allowed tolerance or threshold before employing lethal methods would differ among cooperators and damage situations. In some cases, any loss in value of a resource caused by mammals could be financially burdensome to some people. In addition, establishing a threshold would be difficult or inappropriate to apply to human health and safety situations. For example, conducting activities to prevent an aircraft strike can reduce risks of damage to the aircraft and reduce risks to human safety. For those reasons, WS did not carry this alternative forward for further analysis in Chapter 3.

2.6.7 WS would Require Cooperators Completely Fund Activities (No Taxpayer Money)

This alternative approach WS would require the entity requesting assistance to pay for any activities conducted by WS. Therefore, no activities conducted by WS would occur through federal appropriations or state funding (*i.e.*, no taxpayer money). However, WS is a federal agency that receives funding from federal appropriations. In addition, WS could receive funds through state appropriations and/or through money received from the entity requesting assistance. In those cases where WS receives federal and/or state funding to conduct activities, federal, state, and/or local officials have made the decision to provide funding for damage management activities and have allocated funds for such activities. Additionally, damage management activities are an appropriate sphere of activity for government programs because managing wildlife is a government responsibility. Treves and Naughton-Treves (2005) and the International Association of Fish and Wildlife Agencies (2005) discuss the need for wildlife damage management and that an accountable government agency is best suited to take the lead in such activities because it increases the tolerance for wildlife by those people being impacted by their damage and has the least impacts on wildlife overall. Therefore, WS did not carry this alternative forward for further analysis in Chapter 3.

2.6.8 WS would Implement Alternative 1 but Would Require cooperators Fund the Use of Lethal Methods

This alternative approach would be identical to Alternative 1 except WS would require people requesting assistance to pay for all the costs associated with using lethal methods to resolve their request for assistance. If WS used lethal methods to alleviate or prevent damage, the person requesting assistance would be responsible for paying for the costs associated with those activities. WS could use existing federal and/or state funding to pay for the costs associated with using non-lethal methods to manage damage. WS did not carry this alternative approach forward for further analysis because the environmental consequences associated with the use of this method would be identical to Alternative 1.

2.6.9 WS would Refer Requests for Assistance to Private Nuisance Wildlife Control Agents

People experiencing damage or threats of damage associated with mammals could contact private wildlife control agents and/or other private entities to reduce damage when they deem it appropriate. In addition, WS could refer persons requesting assistance to private wildlife control agents and/or other private entities if WS implemented any of the alternative approaches. WS Directive 3.101 provides guidance on establishing cooperative projects and interfacing with private businesses. WS only responds after receiving a request for assistance. Therefore, WS did not carry this alternative forward for further analysis.

2.6.10 WS would Live-capture and Translocate Mammals Only

Under this alternative, WS would address all requests for assistance using live-capture methods or the recommendation of live-capture methods and WS would translocate all target mammals live-captured. Mammals could be live captured using immobilizing drugs, cage traps, foothold traps, cable restraints, cannon nets, or rocket nets and WS would translocate those mammals to appropriate habitat for release. The success of translocation efforts would depend on efficiently capturing target mammal species and the existence of an appropriate release site (Nielsen 1988).

Translocation sites would be identified and have to be approved by the MDWFP and/or the property owner where the translocated mammals would be placed prior to live-capture and translocation. Live-capture and translocation could be conducted as part of the alternative approaches analyzed in detail. However, the translocation of mammals could only occur under the authority of the MDWFP. Therefore, the translocation of mammals by WS would only occur as directed by the MDWFP. When requested by the MDWFP, WS could translocate mammals or recommend translocation under any of the alternative approaches analyzed in detail, except under the no involvement by WS alternative (Alternative 4). However, translocation by other entities could occur.

Translocation may be appropriate in some situations when the population of a species is low. However, most of the target mammal species are abundant in much of the suitable habitat in Mississippi, and translocation is not necessary for the maintenance of viable populations for those species in the state. Because those mammal species are abundant in Mississippi, the mammals that WS translocated and released into suitable habitat would very likely encounter other mammals of the same species with established territories. For example, even if the MDWFP authorized WS to translocate a coyote, the release of the coyote into suitable habitat would likely occur in areas where other coyotes already occur. Coyotes are territorial, and introducing a translocated coyote into a new area often disorientates the coyote because they are unfamiliar with their surroundings. Therefore, a translocated coyote would often be at a disadvantage. Territorial coyotes often viciously attack other coyotes that wander into their territories. Survival of translocated animals is generally very poor due to the stress of translocation, and in many cases, released animals suffer mortality in a new environment (Craven et al. 1998).

Generally, translocating mammals following live capture that have caused damage to other areas would not be effective or cost-effective. Translocation is generally ineffective because problem mammal species are highly mobile and can easily return to damage sites from long distances, mammals generally already occupy habitats in other areas, and translocation could result in damage problems at the new location. Translocation of wildlife is also discouraged by WS policy (see WS Directive 2.501) because of the stress to the translocated animal, threat of spreading diseases, poor survival rates, and the difficulties that translocated wildlife have with adapting to new locations or habitats (Nielsen 1988). Since WS does not have the authority to translocate mammals in the state unless the MDWFP authorizes the translocations, WS did not consider this alternative in detail.

2.6.11 Reducing Damage by Managing Mammal Populations Through the Use of Reproductive Inhibitors

Under this alternative approach, the only method available to alleviate requests for assistance by WS would be the recommendation and the use of methods that reduce or prevent reproduction in mammals responsible for causing damage. Wildlife professionals often consider reproductive inhibitors for use where wildlife populations are overabundant and where traditional hunting or lethal control programs were not publicly acceptable (Muller et al. 1997). Wildlife professionals could achieve a reduction in local wildlife populations through natural mortality combined with reduced fecundity.

However, population dynamic characteristics (*e.g.*, longevity, age at onset of reproduction, population size, and biological/cultural carrying capacity), habitat and environmental factors (*e.g.*, isolation of target population, cover types, and access to target individuals), socioeconomic factors, and other factors often limit the use and effectiveness of reproductive control as a tool for wildlife population management. Population modeling indicates that reproductive control is more efficient than lethal control only for some rodent and small bird species with high reproductive rates and low survival rates (Dolbeer 1998). Additionally, the need to treat a sufficiently large number of target animals, multiple treatments, and population dynamics of free-ranging populations place considerable logistic and economic constraints on the adoption of reproduction control technologies as an effective wildlife management tool for some species.

Reproductive control for wildlife consists of sterilization (permanent) or contraception (reversible). Sterilization can occur through surgical sterilization (vasectomy, castration, and tubal ligation), chemosterilization, or gene therapy. Contraception could be accomplished through hormone implantation (synthetic steroids such as progestins), immunocontraception (contraceptive vaccines), or oral contraception (progestin administered daily).

An approach would be a trap-neuter-release program where WS would live capture target animals and then either perform a surgical procedure to make animals unable to reproduce or provide the animal to a veterinarian for the surgery. After completing the surgical procedure, WS or another entity would release the animal. People often suggest a trap-neuter-release program to address feral cat colonies and groups of feral dogs. Theoretically, trap-neuter-release programs would work if at least 70% of one sex or both were sterilized each year.

However, performing sterilization procedures during field operations on anesthetized animals can be difficult. Sanitary conditions could be difficult to maintain when performing surgical procedures in field conditions. To perform operations under appropriate conditions, live-captured animals would need to be transported from the capture site to an appropriate facility, which could increase the risk to handlers and to the captured animal from handling and transporting the animal. A mobile facility could be used; however, a mobile facility would still require additional handling and transporting of the live-captured animal to the facility, which would raise concerns about congregating animals. Once the surgical procedure was completed, the animal would have to be held to ensure recovery and transported back to the area where capture occurred. For species that people may harvest, WS would have to adhere to established withdrawal times to prevent people from possibly consuming animals that have immobilizing chemicals present in their bodies.

Trap-neuter-release programs for feral animals are often not as successful as desired and needed to reduce immediate threats posed to wildlife, especially when human safety is a concern (Barrows 2004, Levy and Crawford 2004, Jessup 2004, Winter 2004). Animals sterilized and released would continue to cause the same problems[6] they caused before the procedure because of slow attrition. Trap-neuter-release programs can take a decade or longer to reduce target

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

species populations (Barrows 2004, Winter 2004), especially when acute issues need rapid solutions (Levy and Crawford 2004, Stoskopf and Nutter 2004). Several studies report that target species' populations often remain stable or increase following trap-neuter-release programs due to immigration and reproduction from other members of the groups (Castillo and Clarke 2003, Levy and Crawford 2004, Winter 2004) with little to no resolution of threats to human safety or damages (Organ et al. 1996, Barrows 2004, Slater 2004, Winter 2004).

Bromley and Gese (2001*a*, 2001*b*) conducted studies to determine if surgically sterilized coyotes would maintain territories and pair bond behavior characteristics of unsterilized coyotes, and if predation rates by sterilized coyote pairs would decrease. The results indicated that behaviorally, sterile coyote pairs appeared to be no different from unsterilized pairs, except for predation rates on lambs. Unsterilized coyote packs were six times more likely to prey on sheep than were sterilized packs (Bromley and Gese 2001*b*). Bromley and Gese (2001*b*) believed this occurred because sterile packs did not have to provision pups and food demands were lower. Therefore, sterilization could be an effective method to reduce lamb predation if wildlife professionals could capture and sterilize enough coyote breeding pairs. Bromley and Gese (2001*a*, 2001*b*) captured as many coyotes as possible from all packs on their study area and controlled coyote exploitation (mortality) on their study area. During their studies, Bromley and Gese (2001*a*, 2001*b*) found survival rates for coyotes in the unexploited study area were similar to those survival rates reported for mostly unexploited wild coyote populations. Seidler and Gese (2012) found similar results. Bromley and Gese (2001*b*) concluded a more effective and economical method of sterilizing resident coyotes was needed to make sterilization a practical management tool on a larger scale. Seidler et al. (2014) concluded that surgical sterilization of coyotes could reduce predation rates on pronghorn (*Antilocapra americana*) fawns.

Currently, chemical reproductive inhibitors are not available for use to manage most mammal populations. As alternative methods of delivering chemosterilants are developed, sterilization may prove to be a practical tool in some circumstances (DeLiberto et al. 1998). Given the costs associated with live-capturing and performing sterilization procedures on mammals and the lack of availability of chemical reproductive inhibitors for the management of most mammal populations, WS did not evaluate this alternative approach in detail. If a reproductive inhibitor becomes available to manage a local mammal population and is proven effective in reducing localized mammal populations, WS could evaluate the use of the inhibitor as a method available under the alternative approaches. WS would review and supplement this EA to the degree necessary to evaluate the use of the reproductive inhibitor.

CHAPTER 3: ENVIRONMENTAL EFFECTS

3.1 EFFECTS OF THE ALTERNATIVES

Section 3.1 in this EA analyzes the effects and the environmental consequences of each alternative approach in comparison to determine the extent of actual or potential impacts on each of the issues. Therefore, Alternative 1 serves as the baseline for the analysis and the comparison of expected impacts among the alternative approaches.

3.1.1 Effects of Damage Management Activities on Target Mammal Populations

A common concern amongst federal and state wildlife agencies, tribal authorities, and the public is maintaining viable populations of native wildlife. Conducting damage management activities could impact target mammal populations. The potential for impacts to occur is primarily associated with the use of lethal methods because those methods remove individual animals from a species' population. In addition, some non-lethal methods could impact a species' population. For example, the use of a reproductive inhibitor would limit the reproductive output of adult animals, which can reduce recruitment of new individuals into a species' population. A decline would occur when the number of animals recruited into the population is exceeded by the number that die each year.

The State of Mississippi allows people to harvest many of the mammal species that WS could address to manage damage. The State of Mississippi classifies white-tailed deer, rabbits, and squirrels as game species (Mississippi Code 49-7-1(a)) and Virginia opossums, river otters, raccoons, and bobcats as fur-bearing animals (Mississippi Code 49-7-1(b)). People can harvest game species and fur-bearing animals during annual hunting and/or trapping seasons in Mississippi (*e.g.*, see Mississippi Code 49-7-31, Mississippi Code 49-7-31.1, Mississippi Code 49-7-31.3, Mississippi Code 49-7-31.4). The State of Mississippi has classified feral swine, fox, skunks, and coyotes as nuisance animals (Mississippi Code 49-7-1(c)). People can lethally remove nuisance animals throughout the year on private lands (Mississippi Code 49-7-31.5). Nine-banded armadillos and woodchucks are unclassified species that people can also lethally remove at any time on private property. The State of Mississippi also classifies black bears as a game species (Mississippi Code 49-7-1(a)); however, State of Mississippi also considers black bears to be an endangered species in the state (see Appendix F). Therefore, no hunting season currently exists for black bears in Mississippi.

To adequately determine the magnitude of impacts in relation to target mammal species and their populations, the EA analyzes species data and, when available, lethal removal in Mississippi. The analysis for magnitude of impact from lethal removal can be determined either quantitatively or qualitatively. Quantitative determinations are based on population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations are based on population trends and harvest trend data. Information on mammal populations and trends are often derived from several sources, including published literature and harvest data. Section I in Appendix D discusses the potential impacts of conducting the alternative approaches on the populations of target mammal species for each alternative approach. Potential impacts from Section I in Appendix D are summarized below.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

Implementation of Alternative 1 would allow WS to provide both technical assistance and direct operational assistance to those persons requesting assistance with managing damage and threats caused by mammals. The effects on the populations of target mammal species associated with WS providing technical assistance during the implementation of Alternative 1 would be similar to those effects discussed for Alternative 3. Therefore, to reduce redundancy, the effects associated with WS providing technical assistance that would occur if WS implements Alternative 1 occur in the discussion for Alternative 3.

When providing direct operational assistance, WS could employ those methods described in Appendix C in an adaptive approach that would integrate methods to reduce damage and threats associated with mammals effectively. WS' personnel would use the WS Decision Model (see WS Directive 2.201) to identify the most appropriate damage management strategies and their impacts. If WS implemented Alternative 1, WS' personnel could choose to use any of the methods discussed in Appendix C when using the WS Decision Model to formulate strategies. Therefore, implementation of Alternative 1 would allow WS' personnel to consider the widest range of methods available when formulating strategies to resolve requests for assistance associated with mammals. WS' personnel would employ methods in an adaptive approach that would integrate methods to reduce damage and threats of damage associated with mammals. WS would only use methods after WS and the appropriate entity requesting assistance have signed a work initiation document allowing WS to use those methods on property they own or manage. When practical and effective, WS' personnel would give preference to non-lethal methods pursuant to WS Directive 2.101. In addition, WS could receive requests for assistance to conduct disease surveillance and monitoring in mammal species along with activities to manage a disease outbreak.

Section I in Appendix D discusses the potential impacts of conducting Alternative 1 on the populations of target mammal species. The potential impacts to the populations of target mammal species from implementation of Alternative 1 are summarized below by species.

NINE-BANDED ARMADILLO POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in suitable habitat
Mississippi Classification: Unclassified
Mississippi Population Estimate: 120,000 to 42 million
Annual WS Anticipated Lethal Removal: 200
Impact of WS' Annual Removal on Statewide Population: less than or equal to 0.2%
Average Annual Statewide Harvest (2019-2023): Unknown
Impact on Statewide Population (WS + Average Annual Harvest): Unknown

Nine-banded armadillos are an unregulated wildlife species, which allows people to lethally remove armadillos at any time and without limit. The unlimited removal allowed by the MDWFP provides an indication that nine-banded armadillo populations maintain sufficient densities within the state to sustain unlimited lethal removal and that overharvest is unlikely.

VIRGINIA OPOSSUM POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats
Mississippi Classification: Furbearing animal
Mississippi Population Estimate: 61,000 to 948,000
Annual WS Anticipated Lethal Removal: 150
Impact of WS' Annual Removal on Statewide Population: 0.02% to 0.3%

Average Annual Statewide Harvest (2019-2023): 7,166
Impact on Statewide Population (WS + Average Annual Harvest): 0.8% to 12.0%

The MDWFP allows people to harvest an unlimited number of Virginia opossums during the annual hunting and trapping season in the state, which provides an indication the population of opossums is not likely to decline from overharvest. The lethal removal of Virginia opossum would be of a low magnitude when compared to the actual statewide Virginia opossum population.

BAT POPULATION IMPACT ANALYSIS

Mississippi Distribution: Varies by species
Mississippi Classification: Nongame
Mississippi Population Estimate: Unknown
Annual WS Anticipated Lethal Removal: 5
WS Impact on Statewide Population: Unknown

WS occasionally receives requests for assistance associated with bats in Mississippi and primarily associated with bats found in public areas where people may encounter bats. For most requests for assistance associated with bats, WS would address bats using non-lethal methods. If a bat appeared sick, acted unusually, or if there was a known bite or possible exposure to people or pets, WS would euthanize the bat and would submit the bat for rabies testing. Based on previous requests for assistance received by WS and in those cases where exposure may require a bat be tested, WS does not anticipate live capturing and euthanizing more than five bats total annually. In those cases where human/pet exposure occurred or where WS' personnel or the entity requesting assistance suspect human/pet exposure, those bats euthanized by WS for disease testing would likely be euthanized and submitted for testing by other entities in the absence of WS' involvement given the risk to human safety associated with exposure.

When considering the use and/or recommendation of exclusionary methods and structural repairs, WS would also consider the potential for maternal colonies to be present in buildings and other structures to ensure those damage management activities employed or recommended would not result in the abandonment of young if adults were excluded from returning to maternal colonies. If young were present or if observance of the roosting colony was not possible, WS would not conduct direct operational assistance from May through August. Similarly, property owners requesting technical assistance would also be advised about the possibility of a maternal colony being present from May through August.

Several bat species are being adversely affected by the fungal disease known as white-nose syndrome, an emerging disease that is causing unprecedented morbidity and mortality among bats in eastern North America. WS' limited lethal removal of bats would not adversely affect overall populations of bat species in the state because any bat removal would be localized and limited in scope. WS has not encountered threatened or endangered bat species during previous activities to alleviate damage or threats associated with bats. If the need arises, WS would consult with a qualified biologist to positively identify bats prior to removing them in order to eliminate any chance of addressing a T&E species. If the USFWS designates a bat species as threatened or endangered, WS would not address those bat species.

RABBIT POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats; swamp rabbits associated with wooded wetlands
Mississippi Classification: Game species
Mississippi Population Estimate: Unknown
Annual WS Anticipated Lethal Removal: 50 cottontails and 50 swamp rabbits
Impact of WS' Annual Removal on Statewide Population: Unknown
Average Annual Statewide Harvest (2019-2023): 192,096 (cottontails and swamp rabbits combined)
WS' Removal as a Percentage of Average Annual Statewide Harvest: 0.05%

No population or density estimates are available for cottontails and swamp rabbits in Mississippi. People can harvest cottontails and swamp rabbits in the state during statewide hunting seasons with no limit on the number people can harvest during the hunting season. Studies show that even if hunters harvest as many as 40% of the rabbits available in autumn, the rabbit population the following year would not decline because of the tremendous reproductive potential of rabbits (Fergus 2006). The unlimited removal allowed by the MDWFP during the harvest seasons provides an indication that cottontail and swamp rabbit populations maintain sufficient densities within the state to sustain unlimited harvest and that overharvest is unlikely.

BLACK BEAR POPULATION IMPACT ANALYSIS

The American black bear (*U. a. americanus*) and the Louisiana black bear (*U. a. luteolus*) occur in Mississippi with the Louisiana black bear primarily occurring in southern Mississippi. The State of Mississippi classifies the black bear and the Louisiana black bear as state endangered. At the request of the MDWFP or federal partners, WS could provide technical assistance and/or limited direct operational assistance to assist with managing damage associated with black bears in the state. Direct operational assistance would be limited to WS using live-capture methods and aversion methods. In limited situations, WS could participate in the lethal removal of black bears at the request of the MDWFP. Those situations would likely involve an injured bear or a bear the MDWFP determines to be a threat to human safety. Based on WS' limited involvement and WS' activities only occurring at the request of the MDWFP and/or federal partners, WS' activities would not reach a magnitude or intensity that would have undesirable impacts on the American black bear or Louisiana black bear population in Mississippi.

RACCOON POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats
Mississippi Classification: Furbearing animal
Mississippi Population Estimate: 469,000 to 3.8 million
Annual WS Anticipated Lethal Removal: 150
Impact of WS' Annual Removal on Statewide Population: 0.004% – 0.03%

Average Annual Statewide Harvest (2019-2023): 142,190
Impact on Statewide Population (WS + Average Annual Harvest): 3.8% - 30.3%

Raccoon populations can remain relatively abundant if annual harvest levels are below 49% (Sanderson 1987). The unlimited harvest levels allowed by the MDWFP during the length of the hunting and trapping seasons provides an indication that removal, including removal for damage management, would not reach a level where overharvest of the raccoon population would occur. The MDWFP has regulatory authority over the management of wildlife within the state, including raccoons, and all removal by WS would continue to occur only after the MDWFP authorized the removal and WS' removal would only occur at levels the MDWFP authorized.

RIVER OTTER POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in appropriate aquatic habitat
Mississippi Classification: Furbearing animal
Mississippi Population Estimate: 17,600 – 30,100
Annual WS Anticipated Lethal Removal: 120
Impact of WS' Annual Removal on Statewide Population: 0.4% - 0.7%
Average Annual Statewide Harvest (2019-2023): 1,669
Impact on Statewide Population (WS + Average Annual Harvest): 5.9% - 10.2%

People can harvest river otters in Mississippi during an annual trapping season with no limit on the number of river otters that people can harvest during the trapping season. As with many of the mammal species addressed in this document, the unlimited removal allowed by the MDWFP provides an indication that harvest during the regulated trapping season and removal for damage management, is not likely to reach a level where overharvest would occur.

STRIPED SKUNK POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide
Mississippi Classification: Nuisance animal
Mississippi Population Estimate: 61,000 to nearly 4.6 million
Annual WS Anticipated Lethal Removal: 50
Impact of WS' Annual Removal on Statewide Population: 0.001% - 0.08%
Average Annual Statewide Harvest (2019-2023): 605
Impact on Statewide Population (WS + Average Annual Harvest): 0.01% - 1.1%

People in Mississippi can lethally remove skunks throughout the year on private property with no limit on the number that people can remove. In addition, people can trap skunks on all land types (where allowed) during an annual season that places no limit on the number of skunks that people can harvest. Therefore, the lethal removal of striped skunks in the state is not likely to reach a level where lethal removal would result in adverse effects to their population.

COYOTE POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats

Mississippi Classification: Nuisance animal
Mississippi Population Estimate: 23,462 – 281,544
Annual WS Anticipated Lethal Removal: 100
Impact of WS' Annual Removal on Statewide Population: 0.04% - 0.4%
Average Annual Statewide Harvest (2019-2023): 68,485
Impact on Statewide Population (WS + Average Annual Harvest): ≥27.3%

Mississippi classifies coyotes as "*nuisance animals*" that people can lethally remove on private property throughout the year with no limit on the number that people can remove. In addition, people can harvest coyotes on all land types (where allowed) during the annual trapping season. Based on the estimated harvest data for coyotes and the lack of any indication the coyote population in Mississippi is declining. There is no current evidence that harvest and damage management activities have or would reach a magnitude that would cause a coyote population decline in the state.

Pitt et al. (2001, 2003) assessed the impact of removing a set proportion of a coyote population for one year and then allowing the population to recover. Pitt et al. (2001, 2003) found all coyote populations recovered within one year when <60% of the population was removed and recovery occurred within five years when removal reached 60 to 90% of the population. These findings are consistent with an earlier model developed by Connolly and Longhurst (1975) and revisited by Connolly (1995), which indicated that coyote populations could withstand an annual removal of up to 70% of their numbers and still maintain a viable population. The International Union for Conservation of Nature and Natural Resources indicates coyotes are abundant throughout their range and are generally increasing in distribution with localized removal efforts temporarily reducing population size with populations rebounding quickly through migration and breeding (Kays 2018).

GRAY FOX POPULATION IMPACTS ANALYSIS

Mississippi Distribution: Statewide in areas with suitable habitat
Mississippi Classification: Nuisance animal
Mississippi Population Estimate: 145,000
Annual WS Anticipated Lethal Removal: 50
Impact of WS' Annual Removal on Statewide Population: 0.03%
Average Annual Statewide Harvest (2019-2023): 4,016
Impact on Statewide Population (WS + Average Annual Harvest): 2.8%

People can lethally remove gray fox on private property throughout the year with no limit on the number that people can remove. People can also harvest gray fox during annual trapping seasons. During the annual trapping season, people can harvest an unlimited number of gray fox during the length of the season. People can also hunt gray fox in Mississippi on private property throughout the year. The unlimited removal allowed by the MDWFP during the harvest seasons and the permitting of lethal removal to alleviate damage by the MDWFP provides an indication that gray fox populations maintain sufficient densities within the state to sustain unlimited harvest and that overharvest is unlikely.

RED FOX POPULATION IMPACTS ANALYSIS

Mississippi Distribution: Statewide in areas with suitable habitat
Mississippi Classification: Nuisance animal
Mississippi Population Estimate: 122,000
Annual WS Anticipated Lethal Removal: 50
Impact of WS' Annual Removal on Statewide Population: 0.04%
Average Annual Statewide Harvest (2019-2023): 1,898
Impact on Statewide Population (WS + Average Annual Harvest): 1.6%

The unlimited harvest limits allowed by the MDWFP for the species during hunting and trapping seasons and the classification of the species as a "*nuisance animal*" indicates the species is not at risk of overharvesting. Therefore, the lethal removal of red fox in the state is not likely to reach a level where lethal removal would result in adverse effects to their population.

BOBCAT POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats
Mississippi Classification: Fur-bearing animal
Mississippi Population Estimate: 52,436
Annual WS Anticipated Lethal Removal: 50
Impact of WS' Annual Removal on Statewide Population: 0.1%
Average Annual Statewide Harvest (2019-2023): 7,880
Impact on Statewide Population (WS + Average Annual Harvest): 15.1%

Like other mammal species addressed in this EA, the unlimited harvest allowed by the MDWFP during the hunting and trapping seasons provides an indication that bobcat populations maintain sufficient densities within the state to sustain unlimited harvest and that overharvest is unlikely. The lethal removal of bobcats by WS would only occur when authorized by the MDWFP and only at levels authorized. Based on the limited removal proposed by WS and the oversight by the MDWFP, the lethal removal of bobcats in the state is not likely to reach a level where lethal removal would result in adverse effects to their population.

FERAL SWINE POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats
Mississippi Classification: Nuisance animal; non-native
Mississippi Population Estimate: Unknown
Annual WS Anticipated Lethal Removal: No Limit, 25,000+
Impact of WS' Annual Removal on Statewide Population: Not available
Average Annual Statewide Harvest (2019-2023): 300,855
Impact on Statewide Population (WS + Average Annual Harvest): Not available

The annual removal of feral swine by WS could exceed 25,000 feral swine if populations continue to increase, if additional funding was provided to manage feral swine damage, and the number of requests for assistance continued to increase. There is no maximum limit to the number of swine WS can remove annually under this EA.

Feral swine are considered a non-native species in Mississippi; therefore, maintaining a local and/or statewide population at the lowest level, including extirpation, could be the goal of the MDWFP and to achieve those goals of lowering the statewide population, the annual removal by WS could exceed 25,000 feral swine but there is no maximum limit on take of feral swine.

Activities conducted by WS under the proposed action alternative would occur within the goals and strategies outlined for the statewide feral swine population by the MDWFP. Maintaining a local and/or statewide feral swine population at the lowest level possible could be the goal of the MDWFP. The National Invasive Species Council specifically lists feral swine as an invasive species pursuant to Executive Order 13112. Executive Order 13112 and Executive Order 13751 directs federal agencies to address invasive species to the extent practicable and permitted by law. WS Directive 2.320 provides guidelines for WS' actions in the management of invasive species in fulfillment of Executive Order 13112.

WHITE-TAILED DEER POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide in a variety of habitats
Mississippi Classification: Game animal
Mississippi Population Estimate: 1.5 million to 1.75 million
Annual WS Anticipated Lethal Removal: 700
Impact of WS' Annual Removal on Statewide Population: 0.04% - 0.05%
Average Annual Statewide Harvest (2019-2023): 258,313
Impact on Statewide Population (WS + Average Annual Harvest): 14.8% - 17.3%

WS anticipated lethal removal of white-tailed deer to manage damage and threats of damage includes requests from the MDWFP and/or the MDAC to assist with sampling and managing the spread of diseases found in free-ranging and/or captive white-tailed deer populations. Any involvement with the depopulation of white-tailed deer confined inside a perimeter fence by WS would be at the request of the MDWFP and/or the MDAC. White-tailed deer confined inside perimeter fences for the purposes of non-traditional farming, including confined for hunting, are not included in statewide deer population management objectives. However, because lethal removal of white-tailed deer by WS for disease surveillance or monitoring could occur in free-ranging or captive herds, the potential lethal removal of white-tailed deer for disease surveillance and monitoring by WS was part of the impact analysis on the statewide free-ranging deer population. In addition to WS' intentional removal of white-tailed deer to resolve or prevent damage, WS also conducts other damage management activities that pose a risk of lethally removing white-tailed deer unintentionally. However, WS anticipates the lethal removal would not exceed 700 white-tailed deer per year, including any unintentional take.

GonaCon™ is a reproductive inhibitor available to reduce fertility in female white-tailed deer that WS could use if approved by the MDWFP and the MDAC. The use of reproductive inhibitors to induce a decline in a localized white-tailed deer population occurs through a reduction in the recruitment of fawns into the population by limiting reproductive output of adults. When the number of white-tailed deer recruited into the population cannot replace those individuals that die from other causes each year, a net loss in the number of individuals in the population occurs causing a reduction in a local population. Although a reduction in a local deer population would likely occur from constant use of GonaCon™, the actual reduction in the local population annually would be difficult to derive prior to the initiation of the use of the vaccine because of the variability in the response of deer to the vaccine. Because the effects of GonaCon™ are generally reversible if white-tailed deer do not receive a booster shot periodically, the reduction in a local population of deer from the use of GonaCon™ could be maintained at appropriate levels where damages or threats were resolved by increasing or decreasing the number of deer receiving booster injections.

The magnitude of WS' activities to alleviate damage and threats associated with white-tailed deer in the state would be low with the oversight and permitting of WS' activities occurring by the MDWFP. In addition, WS will evaluate removal, whether intentional or unintentional, to ensure activities do not adversely affect white-tailed deer populations in the state.

FERAL AND FREE-RANGING CAT POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide; usually in association with people
Mississippi Classification: Non-native animal
Mississippi Population Estimate: Unknown
Impact of WS' Annual Removal on Statewide Population: 100
WS Impact on Statewide Population: Unknown

The statewide population of feral and free-ranging cats in Mississippi is unknown but they are generally prolific breeders and can be abundant in areas where they occur (*e.g*., urban areas). WS could live-capture feral and free-ranging cats and relinquish those cats to a local animal control facility. In some cases, WS may use lethal methods to remove cats causing damage or posing a threat of damage. Because WS' activities would be restricted to specific local sites, WS' limited removal of cats would have minimal effects on local populations or the overall population in Mississippi. However, some local populations may be temporarily reduced at a site if cats were removed using non-lethal or lethal methods. In those cases where cats were causing damage or where cats were a nuisance and complete removal of the local population could be achieved, this could be considered as providing some benefit because cats are not considered part of the native ecosystem.

FERAL AND FREE-RANGING DOG POPULATION IMPACT ANALYSIS

Mississippi Distribution: Statewide; usually in association with people
Mississippi Classification: Non-native animal
Mississippi Population Estimate: Unknown
Annual WS Anticipated Lethal Removal: 100
Impact of WS' Annual Removal on Statewide Population: Unknown

When receiving requests for assistance associated with feral and free-ranging dogs, WS would follow WS Directive 2.340. WS would primarily provide technical assistance to requesters when receiving requests associated with feral and free-ranging dogs and would refer most requests for assistance to a local animal control facility. WS could occasionally conduct direct operational assistance when an entity requests such assistance. If requested to provide direct operational assistance, WS could employ live-capture methods to alleviate damage or threats of damage associated with dogs. Once live-captured, WS would transfer custody of the dogs to a local animal control facility.

WS could occasionally receive requests to lethally remove feral dogs to alleviate damage or threats of damage. WS' limited lethal removal of feral and free-ranging dogs should have no adverse effects on overall populations in Mississippi. Any activities conducted by WS involving lethal control actions would be restricted to isolated individual sites. Some local populations may be temporarily reduced because of removal activities aimed at reducing damage at a local site. In those cases where feral dogs were causing damage or posing as a nuisance and complete removal of the local population could be achieved, this would be considered as providing some benefit to the natural environment because feral and free-ranging dogs are not considered part of the native ecosystem.

ADDITIONAL TARGET SPECIES

In addition to those mammal species discussed previously, WS anticipates occasionally receiving requests for assistance associated with woodchucks, southern flying squirrels, Eastern gray squirrels, and fox squirrels. However, WS anticipates receiving requests for those species infrequently and would only lethally remove a few individuals of those species. WS would not lethally remove more than 10 individuals of those species annually. WS' personnel could also lethally remove those species unintentionally during activities targeting other animal species; however, the total annual removal by WS would not exceed 10 individuals of each species.

People can harvest gray squirrels and fox squirrels during annual hunting seasons in the state. Woodchucks are an unregulated species in the state and removal can occur at any time to alleviate damage or threats of damage. The densities of those species in the state are not low. The removal of up to 10 individuals of each of those species would be of extremely low magnitude when compared to the statewide population of those species. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of those species annually would not have adverse effects on the populations of those species.

WS could also receive requests for assistance associated with additional feral or free-ranging mammals, such as domestic animals or pen-raised animals; feral or free-ranging burros, cattle, goats, horses; fallow deer; and other non-native mammal species that have escaped an enclosure or were released due to a natural disaster. For example, WS could receive a request to remove fallow deer for disease testing that have escaped from a hunting enclosure; accidental release of domestic or exotic mammals from vehicle wrecks; and the accidental release of feral animals onto airport properties. The MDWFP and/or the MDAC could request WS' assistance with unique situations where a small number of those mammals have escaped or were released.

There may also be additional need for removing other mammal species in the event of an animal disease outbreak to limit the spread of the disease. As part of the proposed program, WS could provide assistance, upon request, involving exotic and domestic mammals not specifically listed in this EA in emergencies to alleviate threats to human health and safety. Any lethal removal requested would target specific individual mammals and removal would not reach a magnitude where adverse effects would occur to a species' population based on the limited scope of the removal. In most cases, the removal would be limited to a few individuals and removal would likely occur by other entities in the absence of WS' involvement.

WILDLIFE DISEASE SURVEILLANCE, MONITORING, AND MANAGEMENT

Under disease sampling strategies that WS could implement to detect, monitor, or manage diseases in Mississippi, WS' implementation of those sampling strategies would not adversely affect mammal populations in the state. Sampling strategies that WS could employ involve sampling live-captured mammals that could be released on site after sampling occurs. 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 because those mammals would be released unharmed on site. In addition, 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 disease sampling.

WS could conduct targeted lethal removal of certain mammal species to manage risks associated with the detection of a disease, such as the detection of African swine fever and subsequent removal of feral swine to limit the potential spread of the disease. Any purposeful lethal removal of target mammal species for disease sampling would occur within the impacts discussed previously for individual species and further discussed under Alternative 1 in Section I of Appendix D.

EFFECTS OF ACTIVITIES ON BIODIVERSITY AND ECOSYSTEM RESILIENCE

A concern when using lethal methods to manage damage is the potential impacts to a species' population from the lethalremoval of individuals in the population. As part of that concern, declines in a species' population can result in a loss of diversity, which can threaten ecosystem resilience (see Section I in Appendix D).

Most damage management activities conducted by WS would occur in localized areas and would not be conducted throughout the year but would occur for short periods after damage had occurred (*i.e*., reactive damage management). Activities conducted to reduce threats of damage (*i.e*., proactive damage management) would likely occur for short periods during the time of year when addressing those animals would be the most beneficial to reducing threats of damage. WS conducts activities on properties that comprise a small percentage of the land area of the state. In addition, the number of individuals of a species that WS and other entities addresses annually is likely a small percentage of the actual populations of those species in the state; therefore, the effects on biodiversity and ecosystem resilience would be of low magnitude. Section I in Appendix D provides further discussion related to the effects of activities on biodiversity and ecosystem resilience from implementation of Alternative 1.

POTENTIAL TO CAUSE TROPHIC CASCADES, INCLUDING MESOPREDATOR RELEASE

Related to biodiversity, a concern is the potential for a decline of a species population to cause trophic cascades, which can result in mesopredator release (see Section I in Appendix D). As stated previously, WS would only provide assistance after receiving a request to manage damage or threats. Therefore, if WS provided direct operational assistance, WS would provide assistance on a small percentage of the land area of Mississippi. WS would only target those individual mammals identified as causing damage or posing a threat. WS would not attempt to suppress mammal populations across broad geographical areas at such intensity levels for prolonged durations that significant ecological effects would occur. The goal of WS would not be to manage wildlife populations but to manage damage caused by specific individuals of a species.

WS does not attempt to eradicate any species of native wildlife. WS operates in accordance with relevant federal, tribal, and state laws and regulations enacted to ensure species viability. One common concern is that lethally removed animals would only be replaced by other mammals after WS completes activities (*e.g.*, mammals that relocate into the area) or by mammals the following year (*e.g.*, increase in reproduction and survivability that could result from less competition). The anticipated number of individual mammals that WS could lethally remove annually to alleviate damage and threats of damage would be of low magnitude when compared to the available population data. Therefore, based on the low magnitude of impact associated with the small number of mammals that WS could lethally remove annually, the potential to cause trophic cascades or a mesopredator release is highly unlikely to occur. Section I in Appendix D provides further discussion related to the potential for the activities of WS to cause trophic cascades and mesopredator release from implementation of Alternative 1.

EFFECTS ON THE PUBLIC'S ESTHETIC ENJOYMENT OF TARGET MAMMAL SPECIES

Animal populations provide a wide range of social and economic benefits to people, including esthetic benefits. Despite the many benefits of animals, conflicts between animals and people do occur and public opinion about the best ways to reduce conflicts between people and animals is highly variable, which can make the implementation and conduct of damage management activities extremely complex. Some people express concerns that managing damage caused by the target mammal species could interfere with their enjoyment of recreational activities and that WS' activities would result in the loss of esthetic benefits of mammals to the public.

WS only conducts activities on properties where the property owner or property manager signs a work initiation document allowing WS' personnel to conduct activities on properties they own or manage. When conducting activities on those properties, WS' personnel would only target those mammals identified as causing damage or posing a threat of damage. In addition, other individuals of the same species would likely continue to be present in the affected area. Even in the absence of any involvement by WS, other entities could conduct activities to alleviate damage or threats of damage. Therefore, the involvement of WS would not likely be additive to the number of mammals that could be removed in the absence of involvement by WS. In addition, activities that could occur by WS would occur on a relatively limited portion of the total area of Mississippi, and the portion of various mammal species' populations removed would typically be low (see Section 3.1.1 in the EA and Section I in Appendix D). Most of the target species addressed in this EA are relatively abundant and opportunities to view, hear, or see evidence of mammals would still be available.

EFFECTS ON THE ABILITY OF THE PUBLIC TO HARVEST MAMMAL SPECIES

The State of Mississippi has classified many of the mammal species addressed in the EA as game animals or fur-bearing animals, which allows the MDWFP to establish annual hunting and/or trapping seasons for those species. In addition, the State of Mississippi has classified some of the mammal species as nuisance animals, which allows people to harvest those species throughout the year on private property. The MDWFP is responsible for establishing and regulating the annual hunting and trapping seasons in the state while tribes are responsible for managing wildlife on tribal lands.

The magnitude and intensity of the lethal removal that could occur by WS to alleviate damage or threats of damage would be low when compared to those species' populations (see Section 3.1.1 in the EA and Section I in Appendix C). With oversight of most mammal populations by the MDWFP and by the tribes on their tribal lands, the number of mammals that WS could remove annually would not limit the ability of the public to harvest those mammal species during annual hunting and trapping seasons. All removal by WS would be reported to the MDWFP annually to ensure removal by WS could be considered as part of population management objectives established for mammal populations. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of mammals annually would have no effect on the ability of those persons interested to harvest mammals during the regulated harvest season (see Section I in Appendix D).

Alternative 2 – WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

This alternative would require WS to use only non-lethal methods to resolve damage or threats of damage. Non-lethal methods would live-capture, exclude, haze, and/or disperse target mammals from areas where damage or threats were occurring. Non-lethal methods that exclude, haze, and/or disperse target mammals would not be employed over large geographical areas or applied at such intensity that essential resources (*e.g*., habitat, sources of food) would be unavailable for extended durations or over such a wide geographical scope that long-term effects would occur to a target species' population. Non-lethal methods would generally have minimal effects on overall populations of target species because animals are unharmed. No population reduction is likely from the use of non-lethal methods, except for reproductive inhibitors (see discussion for Alternative 2 in Section I of Appendix D).

Other entities could continue to use lethal methods if WS implemented Alternative 2. If those non-lethal methods employed by WS did not reduce damage or threats of damage to levels acceptable to the requester, the requester could seek assistance from other entities or could conduct damage management activities on their own. In some cases, property owners or managers may misuse some methods or use some methods in excess of what was necessary, which could then become hazardous and pose threats to the safety of people and wildlife species. Therefore, similar to Alternative 3 and Alternative 4, if other entities increased their efforts in proportion to those activities that would have been conducted by WS using lethal methods, the potential effects on target mammal populations would be similar to Alternative 1.

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

Mammal populations in the state would not be directly impacted by WS from a program implementing technical assistance only. However, persons experiencing damage or threats from mammals may implement methods based on WS' recommendations. Under technical assistance only alternative, WS would recommend and demonstrate for use both non-lethal and lethal methods legally available for use to resolve mammal damage. Methods and techniques recommended would be based on WS' Decision Model using information provided from the requester or from a site visit. Requesters may implement WS' recommendations, implement other actions, seek assistance from other entities, or take no further action. However, those people requesting assistance would likely be those people that would implement damage abatement methods in the absence of WS' recommendations.

Under Alternative 3, those persons experiencing threats or damage associated with mammals in the state could lethally remove mammals or request assistance from other entities despite WS' lack of direct involvement in the management action. Therefore, under this alternative approach, the number of mammals lethally removed annually would likely be similar to the other alternative approaches because removal could occur through authorization by the MDWFP, removal of non-regulated mammal species could occur without the need for authorization from the MDWFP, and removal would continue to occur during the harvest season for those species. WS' participation in a management action would not be additive to an action that would occur in the absence of WS' participation. Therefore, WS' recommendation of the use of lethal methods under this alternative approach would not limit the ability of those persons interested in harvesting mammals during the regulated season because the MDWFP determines the number of mammals that may be lethally removed during the hunting/trapping season and under permits.

With the oversight of the MDWFP, it is unlikely that mammal populations would be adversely impacted by implementation of this alternative approach. Under Alternative 3, WS would not be directly involved with damage management actions and therefore, direct operational assistance could be provided by other entities, such as the MDWFP, private entities, and/or municipal authorities. If direct operational assistance was not available from WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal removal, which could lead to real but unknown effects on other wildlife populations. People have resorted to the illegal use of chemicals and methods to resolve wildlife damage issues (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015).

Alternative 4 - WS would not provide any assistance with managing damage caused by mammals in Mississippi

Under this alternative, WS would not conduct damage management activities in the state. WS would have no direct involvement with any aspect of addressing damage caused by mammals and would provide no technical assistance. No removal of mammals by WS would occur under this alternative approach. Mammals could continue to be lethally removed to resolve damage and/or threats occurring when authorized by the MDWFP, during the regulated hunting or trapping seasons, or in the case of non-regulated species, removal could occur anytime using legally available methods.

Local mammal populations could decline, stay the same, or increase depending on actions taken by those persons experiencing mammal damage. Some resource/property owners may take illegal, unsafe, or environmentally harmful action against local populations of mammals out of frustration or ignorance. While WS would provide no assistance under this alternative, other individuals or entities could conduct lethal damage management resulting in lethal removal levels similar to the proposed action.

Because mammals could still be removed under this alternative approach, the potential effects on the populations of those mammal species in the state would be similar to the other alternative approaches for this issue. WS' involvement would not be additive to removal that could occur because the cooperator requesting WS' assistance could conduct mammal damage management activities without WS' direct involvement. Therefore, any actions to resolve damage or reduce threats associated with mammals could occur by other entities despite WS' lack of involvement under this alternative. In addition, WS would have no impact on the ability to harvest mammals under this alternative. WS would not be involved with any aspect of mammal damage management. The MDWFP would continue to regulate populations through adjustments of the allowed removal during the regulated harvest season and the continued use of permits.

3.1.2 Effects of Activities on the Populations of Non-target Animals, Including T&E Species

A concern would be the potential impacts to non-target species, including threatened or endangered species, from the use of methods to resolve damage caused by mammals. When using methods, WS could unintentionally live capture, exclude, disperse, or kill non-target animals. A brief discussion on the potential effects of the alternative approaches on the populations of non-target animal species occurs below for each of the alternative approaches identified in Section 2.5. Section II in Appendix D provides further discussion on the effects of the alternative approaches on the populations of non-target species, including T&E species.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

As discussed previously, a concern is often raised about the potential impacts to non-target species, including T&E species, from the use of methods to resolve damage caused by mammals. While WS personnel take precautions to safeguard against taking non-target animals during operational use of methods and techniques for resolving damage and reducing threats caused by mammals, the use of such methods could result in the incidental lethal removal of unintended species. As discussed in Section II of Appendix D, the use of non-lethal methods would not have population level impacts on the populations of non-target species because those species would generally be unharmed. WS could occasionally capture or kill non-target animals unintentionally while conducting activities to alleviate damage caused by mammals in Mississippi. Section II of Appendix C analyzes the potential effects on the populations of non-target wildlife species, including T&E species and are summarized here.

From FY 2019 through FY 2023, WS' personnel lethally removed one Virginia opossum unintentionally during activities targeting mammal species addressed in this EA. Non-target species lethally removed unintentionally by WS in previous years are representative of non-target species that WS could lethally remove in Mississippi if WS implements Alternative 1. Although WS could lethally remove additional species of non-target animals unintentionally, the removal of individuals from any additional species would not be likely to increase substantively above the number of non-target animals removed annually by WS during previous damage management activities. The unintentional removal of non-target animals would likely be minimal with annual removal not exceeding one or two individuals of any species. WS does not anticipate the unintentional lethal removal of non-target animals to occur at such a frequency or intensity that would affect the population of a non-target species. WS would continue to monitor the activities conducted to ensure those activities or methodologies used to manage mammal damage do not adversely affect the populations of non-target animals.

Alternative 2 – WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

Non-lethal methods would live-capture, exclude, haze, and/or disperse target mammals from areas where damage or threats were occurring. Non-lethal methods that exclude, haze, and/or disperse target mammals would not be employed over large geographical areas or applied at such intensity that essential resources (*e.g*., habitat, sources of food) would be unavailable for extended durations or over such a wide geographical scope that long-term effects would occur to a species' population. Non-lethal methods would generally have minimal effects on overall populations of non-target species because animals are unharmed (see Section II in Appendix D).

There is a potential for WS to capture non-target animals unintentionally in live-capture traps (*e.g*., cage traps, foothold traps). When WS' personnel capture a non-target animal alive, they would release the non-target animal on site if the non-target animal would likely survive after release. WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. WS' personnel would check live-capture methods frequently to ensure they address target and non-target animals in a timely manner to minimize distress.

Similar to Alternative 3 and Alternative 4, risks to non-target animals and T&E species would continue to occur because private entities could and would likely continue to use lethal methods and those activities could increase in proportion to the reduction of assistance using lethal methods provided by WS (see Section II in Appendix D).

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

WS would have no direct impact on non-target species, including T&E species because WS would not provide direct operational assistance to people requesting assistance. However, private entities could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of direct assistance provided by WS. Therefore, risks to non-target animals and T&E species would continue to occur from activities conducted by private entities, including from those people who implement damage management activities on their own (see Section II in Appendix D).

Alternative 4 - WS would not provide any assistance with managing damage caused by mammals in Mississippi

WS would not have direct impacts on non-target animals or T&E species because WS would not be directly involved with managing damage caused by mammals in Mississippi. However, risks to non-target animals and T&E species would continue to occur because private entities could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by WS (see Section II in Appendix D).

3.1.3 Effects of Damage Management Activities on Human Health and Safety

A common concern is the potential adverse effects that available methods could have on human health and safety. A brief summarized discussion of the potential effects of the alternative approaches on human health and safety occurs below for each of the alternative approaches identified in Section 2.5. Appendix E provides further discussion on the risks to human health and safety associated with the alternative approaches.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

If WS implements Alternative 1, WS personnel would assess the damage or threat occurring, evaluate the management methods available, and formulate a management strategy to alleviate damage or reduce the risk of damage. A WS employee would formulate a management strategy by selecting from those methods described in Appendix C that the employee determines to be practical for use. WS employees who conduct activities to alleviate mammal damage would be knowledgeable in the use of methods, the wildlife species responsible for causing damage or threats, and WS' directives. WS personnel would incorporate that knowledge into the decision-making process inherent with the WS' Decision Model, which they would apply when addressing threats and damage caused by mammals. Therefore, when evaluating management methods and formulating a management strategy for each request for assistance, WS employees would consider risks to human health and safety associated with methods. In addition, WS would incorporate those protective measures identified in Section 2.4 into activities.

For example, WS personnel would consider the location where activities could occur. Risks to human safety from the use of methods would likely be greater in highly populated urban areas in comparison to rural areas that are less densely populated. If WS personnel conducted activities on rural private property, where the property owner or manager can control and monitor access to the property, the likelihood methods posing a risk to human safety would be lower. If damage management activities occurred at or near public use areas, then risks of the public encountering damage management methods and the corresponding risk to human safety would increase. A discussion of threats to human health and safety associated with WS' use of methods occurs in Appendix E. In general, WS personnel would attempt to conduct activities when the presence of people would be minimal (*e.g.*, early mornings, at night) or in areas where human activity was minimal (*e.g.*, in areas with restricted public access).

WS personnel receive training in the safe use of methods and would follow the safety and health guidelines required by WS' directives (*e.g.*, see WS Directive 2.401, WS Directive 2.425, WS Directive 2.430, WS Directive 2.445, WS Directive 2.450, WS Directive 2.465, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.626, WS Directive 2.627, WS Directive 2.635, WS Directive 2.640).

Before providing direct operational assistance, WS and the entity requesting assistance would complete a work initiation document that would indicate the methods the cooperating entity agrees to allow WS to use on the property they own or property they manage. Thus, the cooperating entity would be aware of the methods that WS could use on property they own or manage, which would help identify any risks to human safety associated with the use of those methods. WS' personnel would also make the cooperator requesting assistance aware of threats to human safety associated with the use of methods.

When required, warning signs would be prominently posted to alert the public when and where, in the general area, methods were deployed (*e.g.*, when using foothold traps, cable devices, body-grip traps). WS would coordinate with cooperators or landowners about where and when methods would be used, thereby decreasing the likelihood of conflicts with the public.

WS could donate edible meat from white-tailed deer lethally removed during damage management activities to charitable organizations for human consumption (see WS Directive 2.510). There could be a concern associated with WS' use of lead ammunition and the consumption of white-tailed deer meat donated to a charitable organization after WS lethally removed the deer using a firearm because of the possible presence of lead fragments in the meat. However, for those reasons discussed for lead ammunition in Section II of Appendix E, WS has concluded the potential of lead toxicity from WS' use of lead ammunition, especially to children who are the most sensitive to the effects of lead, would be negligible (USDA 2022*a*). There is also concern about other contaminants and zoonotic diseases associated with white-tailed deer meat donated for human consumption. However, WS has concluded those risks are also negligible for those reasons discussed on meat donation for human consumption in Section I of Appendix E.

No adverse effects to human health and safety have occurred from WS use of methods to alleviate mammal damage in Mississippi from FY 2019 through FY 2023. WS has developed risks assessments for cage traps, cable devices, foothold traps, aircraft, firearms, GonaCon™, lead, nets, quick-kill traps, dog use, hand capture, explosives materials (*e.g.*, pyrotechnics), exclusion, carcass disposal, registered chemical repellents, minimum risk pesticides, and immobilization and euthanasia methods. The risks to human safety from the use of methods, when used appropriately and by trained personnel, would be low (see Appendix E). Based on the use patterns of methods available to address damage caused by mammals, the use of methods would comply with Executive Order 12898, Executive Order 13045, and Executive Order 13985 (see Section III in Appendix E). Therefore, WS does not expect any significant effects to occur from WS' use of those methods described in Appendix C.

Alternative 2 – WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

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

Non-lethal methods recommended or employed by WS have the potential to threaten human safety. Threats to human safety associated with non-lethal methods that would be available under this alternative approach are addressed in Appendix E. The recommendation and use of non-lethal methods by WS would comply with Executive Order 12898, Executive Order 13045, and Executive Order 13985 (see Section III in Appendix E) under this alternative.

Private entities, including those persons experiencing damage, could still use lethal methods under this alternative. Those entities would likely continue to employ those lethal methods discussed in Section II of Appendix C. If the use of lethal methods by those entities increased in proportion to assistance that WS would have provided using lethal methods, the potential threats to human safety from methods available would be similar to Alternative 1.

Alternative 2 could result in less experienced persons implementing lethal methods and could lead to greater risks to human safety than Alternative 1. Other entities could use lethal methods where WS may not because WS' personnel would follow those protective measures outlined in Section 2.4 to reduce threats to human safety. Lethal methods employed by those persons not experienced in the use of methods or were not trained in their proper use, could increase threats to human safety.

Protective measures that would be followed by WS to reduce threats to human safety are described in Section 2.4. Whereas WS would adhere to those measures, private entities might or might not be required to act in accordance with them, which could lead to a higher risk to human safety than under Alternative 1.

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

If WS implements Alternative 3, WS would have no effect on human health and safety because WS would not directly employ methods. Technical assistance recommendations would be based on WS' Decision Model using information provided by the person requesting assistance or through site visits. Methods recommended or provided through loaning of equipment could be employed by those persons requesting assistance. Therefore, the cooperator requesting assistance would be made aware of threats to human health and safety associated with the use of those methods recommended by WS. Risks to human health and safety from activities and methods recommended under this alternative approach would be similar to the other alternative approaches because the same methods would be available.

Methods recommended could include non-lethal and lethal methods as deemed appropriate by WS' Decision Model and as permitted by laws and regulations. Similar to Alternative 2, private entities could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of direct assistance provided by WS. Threats to human health and safety would continue to occur from activities conducted by private entities, including from those people who implement damage management activities on their own similar to Alternative 2.

When providing technical assistance, WS' personnel would only provide recommendations on methods the requester could use to alleviate damage themselves with no direct involvement by WS. On occasion, WS' personnel could demonstrate the use of methods, but WS' personnel would not conduct any direct operational activities to manage damage caused by mammal species. WS' personnel would only recommend for use those methods that were legally available to the requester for use. The only methods that would have limited availability for use by the public would be immobilizing drugs, euthanasia chemicals, GonaCon™ and the use of aircraft. Immobilizing drugs, euthanasia chemicals, and GonaCon™ would generally not be available for use by the public but other professionals could use those methods or people could use other methods to achieve the same results. Aircraft would also have limited availability for the public to use due to operating cost and the availability of appropriate aircraft.

People that request assistance from WS could conduct activities and use methods recommended by WS' personnel, they could implement other methods, they could seek further assistance from other entities, or they could take no further action. Therefore, the requester and/or other entities would be responsible for using those methods available, including methods recommended by WS. The skill and knowledge of the person applying methods would determine the safety and efficacy of the methods the person was using. If people receiving technical assistance use methods according to recommendations and as demonstrated by WS, the potential risks to human safety would be similar to those risks if WS' personnel were using those methods. If people implement methods inappropriately, without regard for human safety, and/or use methods not recommended by WS, risks to human health and safety could be higher than those risks associated with the implementation of Alternative 1 and Alternative 2. The extent of the increased risk would be unknown and variable. However, methods inherently pose minimal risks to human safety given the design and the extent of the use of those methods.

If misused or applied inappropriately, any of the methods available to alleviate mammal damage could threaten human health and safety. However, when used appropriately, methods available to alleviate damage would pose minimal risks to threaten human safety. The recommendation of methods by WS to people requesting assistance and the pattern of use recommended by WS would comply with Executive Order 12898, Executive Order 13045, and Executive Order 13985 (see Section III in Appendix E).

Alternative 4 - WS would not provide any assistance with managing damage caused by mammals in Mississippi

Under this alternative, WS would not be directly involved with damage management activities in Mississippi. Therefore, no direct impacts to human safety from methods would occur by WS under Alternative 4. However, like Alternative 2 and Alternative 3, private entities could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by WS. Threats to human safety would continue to occur from methods used by private entities, including from those people who implement damage management activities on their own.

The ability to reduce threats to human safety posed by available methods would be variable based upon the skills and abilities of the person implementing damage management actions under Alternative 4. Entities would likely continue to employ those methods discussed in Appendix C because many of those methods would be available to private entities. If the assistance provided by those entities increased in proportion to assistance that WS would have provided, the potential threats to human safety from methods available would be similar to Alternative 1. However, this could result in less experienced persons implementing methods and could lead to greater risks to human safety than Alternative 1. Other entities could use methods where WS may not because WS' personnel would follow those protective measures outlined in Section 2.4 to reduce threats to human safety. Methods employed by those persons not experienced in the use of methods or are not trained in their proper use, could increase threats to human safety.

Protective measures that would be followed by WS to reduce threats to human safety were described in Section 2.4. Whereas WS would adhere to those measures, private citizens might or might not be required to act in accordance with them. This could lead to a higher risk to human safety than under Alternative 1.

3.1.4 Humaneness and Animal Welfare Concerns of Methods

As discussed previously, an issue often raised is concern about the humaneness of methods available under the alternative approaches for resolving mammal damage and threats. 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*." As discussed previously, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal. People may perceive the humaneness of an action differently. Schmidt and Brunson (1995) conducted a public attitude survey in which respondents were asked to rate a variety of methods on humaneness based on their individual perceptions of the methods. Schmidt and Brunson (1995) found that the public believes that the non-lethal methods, such as animal husbandry, fences, and scare devices, were the most humane and traps, snares, and shooting from aircraft was the least humane. The challenge in coping with this issue is how to achieve the least amount of animal suffering.

Some people believe any use of lethal methods to resolve damage associated with wildlife is inhumane because the resulting fate is the death of the animal. Others believe that certain lethal methods can lead to a humane death. Some people believe most non-lethal methods of capturing wildlife to be humane because the animal is generally unharmed and alive. Still others believe that any disruption in the behavior of wildlife is inhumane. With the multitude of attitudes on the meaning of humaneness and the varying perspectives on the most effective way to address damage and threats in a humane manner, agencies are challenged with conducting activities and employing methods that are perceived to be humane while assisting those persons requesting assistance to manage damage and threats associated with wildlife.

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

The issues of method humaneness and animal welfare relating to the alternative approaches are discussed below.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

Under Alternative 1, WS personnel would formulate management strategies for each request for assistance by conducting a local problem analysis (see WS Directive 2.201). Methods that the employee determines to be practical for use would be the basis for each management strategy. When conducting a local problem analysis, WS employees would consider many factors essential to formulating each management strategy, including method humaneness and concerns for the welfare of animals. The goal of WS would be to use methods as humanely as possible to resolve requests for assistance associated with mammals. WS would continue to evaluate methods and activities to minimize the pain and suffering of methods addressed when attempting to resolve requests for assistance.

When formulating a management strategy using the WS Decision Model, WS personnel would give preference to the use of non-lethal methods, when practical and effective, pursuant to WS Directive 2.101. Although some issues of humaneness could occur from the use of non-lethal methods, when used appropriately and attended to by trained personnel, those methods would not result in the inhumane treatment of target mammal species. The non-lethal methods of primary concern would be the use of methods that capture and restrain an individual or individuals alive, such as cage traps. Concerns from the use of non-lethal methods would be from injuries and stress to the animal while restrained or during the application of the method. Although stress could occur to animals while restrained, timely attention to live-captured animals would alleviate suffering. In addition, stress experienced by animals would likely be temporary because WS personnel would check methods in accordance with the laws and regulations in Mississippi to address those animals live-captured in a timely manner.

WS could employ lethal methods to alleviate or prevent mammal damage and threats, when requested. Section II in Appendix C discusses the lethal methods that WS could use to manage mammal damage in Mississippi. WS' Directive 2.505 would provide guidance to WS personnel when they used lethal methods. WS personnel would exhibit a high level of respect and professionalism when conducting activities that result in the lethal removal of mammals. WS personnel would be familiar with the methods described in current AVMA guidelines for euthanasia. Whenever possible, WS personnel would use those methods to euthanize captured or restrained mammals. When using immobilizing drugs and euthanasia chemicals, WS personnel would follow the guidance in WS Directive 2.430.

WS personnel would be familiar with the current AVMA guidelines for euthanasia (see WS Directive 2.505). The euthanasia methods that WS is considering for use under this alternative for live-captured mammals are carbon dioxide, gunshot, and barbiturates or potassium chloride in conjunction with general anesthesia. When used appropriately, the AVMA (2020) considers those methods to be acceptable forms of euthanasia. The use of carbon dioxide, barbiturates, and potassium chloride for euthanasia would occur after the animal was live-captured and would occur away from public view. Although the AVMA guideline also lists gunshot as a conditionally acceptable method of euthanasia for free-ranging wildlife, there is greater potential the method may not consistently produce a humane death (AVMA 2020). The goal of WS would be to use methods as humanely as possible to resolve requests for assistance associated with mammals.

Research and development by the National Wildlife Research Center has improved the selectivity and humaneness of management techniques. Research is continuing to bring new findings and products into practical use. For example, Lovallo et al. (2021) evaluated the welfare performance of three foothold traps for capturing river otters. Until new findings and products were found practical, a certain amount of animal suffering could occur when some methods were used in situations where non-lethal damage management methods were not practical or effective. As stated previously, research suggests that some methods, such as restraint in foothold traps or changes in the blood chemistry of trapped animals, indicate "*stress*" (Kreeger et al. 1990). However, such research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991, Sharp and Saunders 2008, Sharp and Saunders 2011). Therefore, the goal would be to address requests for assistance effectively using methods in the most humane way possible that minimizes the stress and pain to the animal. Protective measures that would be incorporated into activities conducted by WS to ensure methods were used as humanely as possible are listed in Section 2.4.

Alternative 2 – WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

Under this alternative, only non-lethal methods would be used by WS, which would generally be regarded as humane. Non-lethal methods would include modifying cultural practices, limited habitat management, supplemental feeding, exclusion methods, visual scaring techniques, paintballs (and similar projectiles), trained dogs, guard animals, nets, hand capture, catch pole, cage-type traps, foothold traps, translocation, unmanned aerial vehicles, aerial operations, scout animals, GonaCon™, immobilizing drugs, repellents, and attractants.

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

Overall, use of non-lethal methods would be regarded as humane when used appropriately. Although some concern arises from use of live-capture methods, the stress of animals would likely be temporary and would cease once the animal was released. Similar to the other alternative approaches, other entities could continue to use lethal methods.

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

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

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

In addition, the issue of humaneness would continue to occur from methods used by those people who implement damage management activities on their own. Those entities and people experiencing damage or threats associated with mammals could continue to use those methods legally available.

Alternative 4 - WS would not provide any assistance with managing damage caused by mammals in Mississippi

Under this alternative, WS would not be involved with any aspect of mammal damage management in Mississippi. Like Alternative 2 and Alternative 3, private entities could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by WS. The issue of humaneness would continue to occur from methods used by private entities, including from those people who implement damage management activities on their own. Those entities and people experiencing damage or threats associated with mammals could continue to use those methods legally available.

Those methods would likely be considered inhumane by those persons who would consider methods proposed under any alternative approach as inhumane. The issue of humaneness would likely be directly linked to the methods legally available to the public because methods are often labeled as inhumane by segments of society no matter the entity employing those methods. The humaneness of methods would be based on the skill and knowledge of the person employing those methods.

A lack of understanding of the target species or methods used could lead to an increase in situations perceived as being inhumane to wildlife despite the method used. Despite the lack of involvement by WS under this alternative approach, those methods perceived as inhumane by certain individuals and groups would still be available to use to resolve damage and threats caused by mammals. Under this alternative approach, euthanasia or killing of live-captured animals would also be determined by those persons employing methods to live-captured wildlife.

3.2 ISSUES NOT CONSIDERED FOR COMPARATIVE ANALYSIS

WS and the TVA identified and considered additional issues during the scoping process of this EA, but a detailed analysis does not occur in Chapter 3. Discussion of those additional issues and the reasons for not analyzing those issues in detail occur below.

3.2.1 Effects of Activities on Other Environmental Resources

The implementation of those alternative approaches discussed in Section 2.4 would meet the requirements of applicable federal laws, regulations, and Executive Orders for the protection of the environment, including the Clean Air Act and the Clean Water Act. The actions described in Section 2.5 do not involve major ground disturbance, construction, or habitat alteration. Implementation of those alternative approaches discussed in Section 2.5 would not cause changes in the flow, quantity, quality, or storage of water resources. The use and storage of methods by WS' personnel would also follow WS' directives, including WS Directive 2.210, WS Directive 2.401, WS Directive 2.405, WS Directive 2.425, WS Directive 2.430, WS Directive 2.465, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.626, WS Directive 2.627, WS Directive 2.635, and WS Directive 2.640.

For example, WS' use of chemical immobilization and euthanizing agents would occur pursuant to WS Directive 2.430. WS would also follow WS Directive 2.401, which provides for the safe and effective storage, disposal, recordkeeping, and use of pesticides. When using pesticides, WS would follow product labels to minimize risks of environmental hazards.

Most methods available for use to manage damage caused by mammals are mechanical methods. Mechanical methods would not cause contaminants to enter water bodies or result in bioaccumulation. For example, firearms are mechanical methods used to remove a target animal lethally and to reinforce the noise associated with non-lethal methods, such as pyrotechnics. Firearms would not enter bodies of water and would be securely stored off-site after each use; therefore, the firearm itself would not contaminate water or result in the bioaccumulation of chemicals or other hazardous materials.

The deposition of lead into the environment from ammunition used in firearms to lethally remove mammals is often a concern. In an ecological risk assessment of lead shot exposure in non-waterfowl birds, ingestion of lead shot was identified as the concern rather than just contact with lead shot or lead leaching from shot in the environment (Kendall et al. 1996). With risks of lead exposure occurring primarily from ingestion of bullet fragments and lead shot, the retrieval and proper disposal of carcasses would greatly reduce the risk of scavengers ingesting lead contained within a carcass. However, deposition of lead into soil could occur if, during the use of a firearm, the projectile passed through an animal, if WS personnel missed the target, or if WS' personnel were not able to retrieve the carcass. In addition, concerns occur that lead from bullets deposited in soil from shooting activities could contaminate ground water or surface water.

Although Stansley et al. (1992) detected elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at a shooting range, the study did not find higher lead levels in a lake into which the stream drained, except for one sample collected near a parking lot. Stansley et al. (1992) believed the lead contamination near the parking lot was due to runoff from the lot, and not from the shooting range areas. The study also indicated that even when lead shot was highly accumulated in areas with permanent water bodies present, the lead did not necessarily cause elevated lead levels in water farther downstream. Muscle samples from two species of fish collected in water bodies with high lead shot accumulations had lead levels that were well below the accepted threshold standard of safety for human consumption (Stansley et al. 1992).

Craig et al. (1999) found that the dissolution (*i.e.*, capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments, which reduces the transport of lead across the landscape and naturally serves to reduce the potential for ground or surface water contamination. Laidlaw et al. (2005) reported that, because of the low mobility of lead in soil, the lead that accumulates on the surface layer of the soil generally stays within the top 20 cm (about eight inches). Lead does not appear to "*transport*" readily in surface water when soils were neutral or slightly alkaline in pH (*i.e.*, not acidic), but lead may transport more readily under slightly acidic conditions (Stansley et al. 1992, The Wildlife Society 2022). The environmental fate of lead once it degrades suggests the small amounts of lead that may end up in the environment because of WS' activities would not have adverse impacts on soil, air, and water quality (USDA 2022*a*).

When conducting activities using lethal methods, WS would dispose of retrieved carcasses in accordance with WS Directive 2.510 and WS Directive 2.515. When euthanizing a target animal using euthanasia chemicals, WS would dispose of the carcass to prevent scavengers from ingesting the euthanasia chemical. In many cases, WS would retrieve and dispose of mammal carcasses lethally removed using firearms to prevent the ingestion of lead in carcasses by scavengers. Based on current information, the risks associated with lead ammunition that WS' activities could deposit into the environment due to misses, the bullet passing through the carcass, or from animal carcasses that WS does not retrieve would be below any level that would pose any risk from exposure or significant contamination. WS would not use lead ammunition at a magnitude that activities would deposit a large number of spent bullets or shot in such a limited area that would result in large accumulations of lead in the soil (USDA 2022*a*). WS may utilize non-toxic ammunition in shotguns, rifles, air rifles, and handguns as the technology improves and ammunition becomes more effective and available.

WS could also use a fixed-winged aircraft or helicopter to survey, locate, monitor, and shoot certain mammal species and, like any other flying, may result in an accident. Pilots and crewmembers receive training and have experience to recognize the circumstances that lead to accidents. The national WS Aviation Program has a strong emphasis on safety, including funding for training, the establishment of a WS Flight Training Center, and annual recurring training for all pilots. In addition, the national WS program has developed a comprehensive Aviation Operations and Safety Manual that provides guidance to WS personnel when conducting aerial operations. However, accidents may still occur. Nationwide, the WS program has been using aircraft during aerial operations for many years. During this time, no incidents of major ground fires associated with WS aircraft accidents have occurred; thus, the risk of catastrophic ground fires caused by an aircraft accident is extremely low (USDA 2019*c*).

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

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

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

For those reasons, the risk of ground fires or fuel/oil pollution from aviation accidents would be low. In addition, based on the history and experience of the program in aircraft accidents, it appears the risk of environmental damage from such accidents is exceedingly low (USDA 2019*c*).

Currently, the two principal types of fuel used in aviation today are aviation gasoline (commonly referred to as avgas) and jet fuel. Aviation gasoline is the only transportation fuel that still contains a lead additive in the United States. Jet fuel does not contain a lead additive (Federal Aviation Administration 2019). The helicopters that WS could use to conduct certain activities would use jet fuel, which does not contain lead. In Mississippi, most activities involving the use of an aircraft would involve the use of a helicopter given the terrain and habitats that dominate the state. However, WS could occasionally use airplanes to conduct monitoring and surveillance activities. The airplanes that WS utilizes could use aviation gasoline. The Federal Aviation Administration is committed to developing an alternative fuel or fuels for use in airplanes that do not contain a lead additive and is currently testing several unleaded fuel candidates (Federal Aviation Administration 2024). When the Federal Aviation Administration approves the general use of an alternative fuel or fuels and the fuel or fuels become readily available for use, WS would use the alternative fuel or fuels. Because WS infrequently uses aircraft in Mississippi and would transition to the use of unleaded fuels when approved and readily available, WS' emission of lead into the environment of Mississippi from the use of avgas containing a lead additive would be extremely low and would eventually end once alternative fuels are approved and readily available for use.

Through programmatic risk assessments, WS has determined the use of cage traps (USDA 2019*d*), cable devices (USDA 2019*e*), foothold traps (USDA 2019*f*), aircraft (USDA 2019*c*), firearms (USDA 2019*g*), carbon monoxide (USDA 2019*h*), GonaCon™ (USDA 2022*b*), lead (USDA 2022*a*), nets (USDA 2020), quick-kill traps (USDA 2022*c*), dog use (USDA 2021), hand capture (USDA 2023*a*), explosive materials (*e.g*., pyrotechnics) (USDA 2023*b*), exclusion (USDA 2022*d*), carcass disposal (USDA 2023*c*), registered chemical repellents (USDA 2024*a*), immobilization and euthanasia methods (USDA 2024*b*), and minimum risk pesticides (USDA 2024*c*) to manage wildlife damage pose minimal risks to the environment. WS has not received reports or documented any effects associated with previous activities associated with managing damage caused by mammal species in Mississippi. Therefore, implementing any of the alternative approaches discussed in Section 2.5 would not significantly alter the environmental status quo with respect to soils, geology, minerals, water quality and quantity, floodplains, wetlands, other aquatic resources, air quality, prime and unique farmlands, timber, and range. Those resources will not be analyzed further.

3.2.2 Actions Would Result in Irreversible and Irretrievable Commitments of Resources

Other than relatively minor uses of fuels for vehicles/aircraft; electricity for office operations and Unmanned Aerial Vehicles; carbon dioxide for euthanasia; applied euthanasia chemicals; applied immobilization drugs; applied repellents; some components associated with ammunition (*e.g*., black powder, shot); gas cartridges; and pyrotechnics (*e.g*., black powder, cardboard), no irreversible or irretrievable commitments of resources result from WS' activities.

3.2.3 Impacts on Cultural, Archaeological, Historic, and Tribal Resources and Unique Characteristics of Geographic Areas

Different types of federal and state lands occur within the analysis area; however, most of the land within Mississippi is private lands. Activities could occur in areas with cultural, archaeological, historic, and/or tribal resources if the appropriate owner, manager, or tribal authority requests assistance. WS would only provide direct operational assistance in Mississippi if WS implements Alternative 1 or Alternative 2 (see Section 2.5). WS would provide no assistance with managing damage caused by mammals if WS implements Alternative 4 and WS would only provide technical assistance if WS implements Alternative 3.

WS recognizes the rights of sovereign tribal nations, the unique legal relationship between each tribe and the federal government, and the importance of strong partnerships with Native American communities. WS is committed to respecting tribal heritage and cultural values when planning and initiating wildlife damage management programs. Consultation and coordination with tribal governments is conducted consistent with Executive Order 13175 and the Animal and Plant Health Inspection Service plan implementing Executive Order 13175.

The methods available for use would not cause major ground disturbance and would not cause any physical destruction or damage to property. The methods available would not cause any major alterations of property, wildlife habitat, or landscapes, and would not involve the sale, lease, or transfer of ownership of any property. In general, activities would not have the potential to introduce visual, atmospheric, or audible elements to areas that could result in effects on the character or use of properties. Therefore, the methods would not have the potential to affect the unique characteristics of geographic areas or any cultural, archeological, historic, and tribal resources. If WS implements Alternative 1 or Alternative 2 and WS planned an individual activity with the potential to affect historic resources, WS and/or the entity requesting assistance would conduct the site-specific consultation, as required by Section 106 of the National Historic Preservation Act, as necessary.

Conducting activities at or in close proximity to historic or cultural sites for the purposes of alleviating damage caused by mammals would have the potential for audible effects on the use and enjoyment of the historic property. For example, WS could use firearms to remove mammals. However, WS would only use such methods at a historic site after the property owner or manager signed a work initiation document allowing WS to conduct activities on their property. A built-in minimization factor for this issue is that nearly all the methods involved would only have temporary effects on the audible nature of a site and could be ended at any time to restore the audible qualities of such sites to their original condition with no further effects.

In addition, activities would only occur on tribal lands at the request of the Tribe and only after signing appropriate authorizing documents. Therefore, the Tribe would determine what activities they would allow and when assistance was required. Because Tribal officials would be responsible for requesting assistance and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would likely occur. WS would also adhere to the Native American Graves Protection and Repatriation Act. If Native American cultural items were located while conducting activities on federal or tribal lands, WS would notify the land manager and would discontinue work at the site until authorized by the managing entity.

WS would abide by federal and state laws, regulations, Memorandums of Understanding, and policies to minimize any effects and would abide by any restrictions imposed by the land management agency on activities conducted by WS. The implementation of the alternative approaches discussed in Section 2.5 would meet the requirements of applicable federal laws, regulations, and Executive Orders for the protection of the unique characteristics of geographic areas or any cultural, archeological, historic, and tribal resources; therefore, the EA will not discuss this issue in further detail.

3.3 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Based on the best available information, the analyses in Section 3.1.1 indicate the effects on mammal populations associated with implementing Alternative 1 would be of low magnitude. The lethal removal of mammals from all known sources of mortality would not reach a threshold that would cause a decline in their respective populations. WS would direct management actions toward localized populations, individuals, or groups of target species. WS would not conduct generalized population suppression across the entire state, or even across major portions of Mississippi. The implementation of Alternative 2, Alternative 3, or Alternative 4 would likely have similar effects on mammal populations to implementing Alternative 1 because the same or similar activities would occur by other entities.

WS' personnel would have experience with managing animal damage and would receive training in the use of methods, which would allow WS' employees to use the WS Decision Model to select the most appropriate methods to address damage caused by mammals and to reduce the risks to non-target animals. WS would use lures, trap placement, and capture devices that employees would strategically place at locations likely to capture a target animal and minimize the potential of non-target animal captures. The unintentional removal of animals would likely be limited and would not reach a magnitude where adverse effects would occur. WS' personnel would release any non-target animals live-captured in cage traps or any other restraining device whenever it was possible and safe to do so. Based on the methods available to resolve mammal damage and/or threats, WS does not anticipate the number of non-target animals lethally removed to reach a magnitude where declines in those species' populations would occur.

Therefore, lethal removal under the proposed action/no action alternative (Alternative 1) of non-target animals would not significantly affect non-target species. WS has reviewed the T&E species listed by the MDWFP, USFWS, and National Marine Fisheries Service. WS has consulted with the USFWS pursuant to Section 7 of the Endangered Species Act. Impacts would be minimal on non-target animals from any of the alternative approaches discussed. If WS implemented Alternative 3, the knowledge and skill of those persons implementing recommended methods would determine the potential for impacts to occur. If those persons experiencing damage do not implement methods or techniques correctly, the potential impacts from providing only technical assistance could be greater than Alternative 1. The incorrect implementation of methods or techniques recommended by WS could lead to an increase in non-target animal removal when compared to the non-target animal removal that could occur by WS under Alternative 1. Similarly, if WS implemented Alternative 4, the knowledge and skill of those persons implementing methods would determine the potential for impacts to occur. If those persons experiencing damage do not implement methods or techniques correctly, the potential impacts from implementing Alternative 4 could be greater than Alternative 1.

The risks to human health and safety from the use of available methods, when used appropriately and by trained personnel, would be low. When formulating management strategies using the WS Decision Model, WS' employees would consider risks to human health and safety associated with the activities. WS' employees would conduct damage management activities professionally and in consideration of human health and safety. Whenever possible, employees would conduct damage management activities away from areas of high human activity or when human activity was low (*e.g.*, early morning). No adverse effects to human safety have occurred from WS' use of methods to alleviate mammal damage in the state from FY 2019 through FY 2023. Based on the use patterns of methods available to address damage caused by mammals, implementation of Alternative 1 would comply with Executive Order 12898, Executive Order 13045, and Executive Order 13985. Other entities have and could continue to conduct activities to manage mammal damage in the state. If people implemented methods appropriately and in consideration of human safety, threats to human health and safety would be minimal. If people implemented methods inappropriately, without regard for human safety, and/or used illegal methods, risks to human health and safety would increase.

People experiencing damage or threats of damage associated with mammals could use many of those methods discussed in Appendix C regardless of the alternative approach implemented by WS. If WS implemented Alternative 2, Alternative 3, or Alternative 4, the only methods that would be limited by availability for use by the public would be immobilizing drugs, euthanasia chemicals, aerial operations, and GonaCon™. Immobilizing drugs, euthanasia chemicals, and GonaCon™ would generally not be available for use by the public but other professionals could use those methods or people could use other methods to achieve the same results, such as using a firearm to remove deer.

Therefore, the issue of humaneness associated with methods would be similar across any of the alternative approaches because people could use many of those methods 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 alternative approaches. In addition, many "*humane*" methods can be inhumane if not used appropriately. WS' personnel would check methods in accordance with the laws and regulations in Mississippi to address those mammals live-captured in a timely manner, which would minimize the stress of the animal. WS' personnel would be familiar with current methods in the AVMA guidelines for euthanasia and would exhibit a high level of respect and professionalism when taking an animal's life, regardless of method (see WS Directive 2.505). WS' personnel would give preference to non-lethal methods when they determine those methods to be practical and effective (see WS Directive 2.101).

If WS implements Alternative 1, all activities would comply with relevant laws, regulations, policies, orders, procedures, and WS' directives. In addition, WS would review this EA periodically to ensure activities and their impacts remain consistent with the activities and impacts analyzed in this EA. Monitoring activities would ensure that WS' activities and the effects of those activities occurred within the limits of evaluated/anticipated activities. Monitoring involves review of the EA for all of the issues evaluated in Chapter 3 to ensure that the activities and associated impacts have not changed substantially over time.

APPENDIX A. LITERATURE CITED

Aebischer, N. J., C. J. Wheatley, and H. R. Rose. 2014. Factors associated with shooting accuracy and wounding rate of four managed deer species in the UK, based on anonymous field records from deer stalkers. PLOS One 9(10): e109698. doi: 10.1371/journal.pone.0109698

Air National Guard. 1997. Final environmental impact statement for the Colorado Airspace Initiative, Vol. 1. Impact Analyses. National Guard Bureau, Andrews Air Force Base, Maryland.

Allen, G. T., J. K. Veatch, R. K. Stroud, C. G. Vendel, R. H. Poppenga, L. Thompson, J. Shafer, and W. E. Braselton. 1996. Winter poisoning of coyotes and raptors with Furadan-laced carcass baits. Journal of Wildlife Diseases 32:385-389.

Allen, S. H., J. O. Hastings, and S. C. Kohn. 1987. Composition and stability of coyote families and territories in North Dakota. Prairie Nat. 19:107-114.

Alt, G. L. 1981. Reproductive biology of black bears of northeastern Pennsylvania. Trans. Northeast Fish and Wildlife Conference 38:88-89.

AVMA. 2020. American Veterinary Medical Association Guidelines for the Euthanasia of Animals: 2020 Edition. https://www.avma.org/sites/default/files/2020-02/Guidelines-on-Euthanasia-2020.pdf. Accessed November 18, 2024.

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

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

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

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

Anderson, E. M. 1987. A critical review and annotated bibliography of literature on the bobcat. Special Report Number 62, Colorado Division of Wildlife, Denver, Colorado.

Anderson, E. M., and M. J. Lovallo. 2003. Bobcat and lynx. Pp 758-786 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Andrzejewski R. and E. Owadowska. 1994. Use of odour bait to catch bank voles. Acta Theriologica 39:221-225.

APHIS. 2012. USDA letter to Director, Land and Wildlife Program, Natural Resources Defense Council, regarding the use of lead ammunition in wildlife damage management (WDM) activities.

Archer, J. 1999. The nature of grief: the evolution and psychology of reactions to loss. Taylor & Francis/Routledge, Florence, Kentucky. 317 pp.

Association of Fish and Wildlife Agencies. 2009. Modern snares for capturing mammals: Definitions, mechanical attributes and use considerations. AFWA, Furbearer Conservation Technical Work Group. 24 pp.

Association of Fish and Wildlife Agencies. 2021. Best management practices for trapping in the United States. Association of Fish and Wildlife Agencies website. https://www.fishwildlife.org/application/files/4716/3846/4836/Introduction_BMP__2021.pdf. Accessed November 19, 2024.

Awbrey, F. T., and A. E. Bowles. 1990. The effects of aircraft noise and sonic booms on raptors: A preliminary model and a synthesis of the literature on disturbance. Noise and Sonic Boom Impact Technology, Technical Operating Report 12. Wright-Patterson Air Force Base, Ohio.

Bailey, E. P. 1993. Introduction of foxes to Alaska islands – history, effects on avifauna, and eradication. Resource Publication 193, U. S. Fish and Wildlife Service, Washington, D.C. 53 pp.

Bailey, T. N. 1972. Ecology of bobcats with special reference to social organization. Ph.D. Thesis, Univ. Idaho, Moscow, Idaho. 82 pp.

Baker, S. J., and C.M. Clarke. 1988. Cage Trapping Coypus (*Myocastor coypus*) on Baited Rafts. J. Appl. Ecol. 25:41-48.

Baker, P. J., Harris, S., Robertson, C. P. J., Saunders, G. and P. C. L. White. 2001. Differences in the capture rate of cage-trapped red foxes Vulpes vulpes and an evaluation of rabies control measures in Britain. J. Appl. Ecol. 38:823-835.

Barrett, R. H. and G. H. Birmingham. 1994. Wild pigs. Pp. D65-D70 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Nebraska

Barrows, P. L. 2004. Professional, ethical, and legal dilemmas of trap-neuter-release. Journal of the American Veterinary Medical Association 225:1365–1369.

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

Beach, R. 1993. Depredation problems involving feral hogs. Pp. 67-75 *in* C. W. Hanselka and J. F. Cadenhead, eds. Feral swine: a compendium for resource managers. Texas Agric. Ext. Serv., College Station, Texas.

Beasom, S. L. 1974. Intensive short-term predator removal as a game management tool. Pp. 230-240 in J. B. Trefethen and K. J. Sabol, eds, Transactions of the Thirty-ninth North American Wildlife and Natural Resources Conference.

Bekoff, M., and E. M. Gese. 2003. Coyote. Pp 467-481 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Belanger, L., and J. Bedard. 1989. Responses of staging greater snow geese to disturbance. Journal of Wildlife Management 53:713-719.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management 54:36-41.

Belant, J. L., T. W. Seamans, and C. P. Dwyer. 1996. Evaluation of propane exploders as white-tailed deer deterrents. Crop Protection 15(6):575-578.

Benevides, Jr, F. L., Hansen, H., and S. Hess. 2008. Design and Evaluation of a Simple Signaling Device for Live Traps. Journal of Wildlife Management 72:1434-1436.

Beran, G. W. 1994**.** Handbook of zoonoses. Boca Raton, Florida, CRC Press. 1168 pp.

Berger, J., P. B. Stacey, L. Bellis, and M. P. Johnson. 2001. A mammalian predator-prey imbalance: grizzly bear and wolf extinction affect avian neotropical migrants. Ecological Applications 11:947-960.

Berger, K. M., and M. M. Conner. 2008. Recolonizing wolves and mesopredator suppression of coyotes: impacts on pronghorn population dynamics. Ecological Applications 18:599–612.

Bergstrom, B. J., L. C. Arias, A. D. Davidson, A. W. Ferguson, L. A. Randa, and S. R. Sheffield. 2014. License to kill: Reforming federal wildlife control to restore biodiversity and ecosystem function. Conservation Letters 7:131-142.

Berryman, J. H. 1991. Animal damage management: Responsibilities of various agencies and the need for coordination and support. Proc. East. Wildl. Damage Control Conf. 5:12-14.

Beschta, R. L., and W. J. Ripple. 2006. River channel dynamics following extirpation of wolves in northwestern Yellowstone National Park, USA. Earth Surface Processes and Landforms 31:1525–1539.

Beschta, R. L., and W. J. Ripple. 2008. Wolves, trophic cascades, and rivers in the Olympic National Park, USA. Ecohydrology 1:118-130.

Beschta, R. L. and W. J. Ripple. 2012*a*. Berry-producing shrub characteristics following wolf reintroduction in Yellowstone National Park. Forest Ecology and Management 276:132-138.

Beschta, R. L. and W. J. Ripple. 2012*b*. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157-158:88-98.

Bevan, D. J., K. P. Chandroo, and R. D. Moccia. 2002. Predator control in commercial aquaculture in Canada. < https://animalbiosciences.uoguelph.ca/aquacentre/files/misc-factsheets/Predator%20Control%20in%20Commercial%20Aquaculture%20in%20Canada.pdf >. Accessed November 18, 2024.

Bishop, R. C. 1987. Economic values defined. Pp 24 -33 *in* D. J. Decker and G. R. Goff, eds. Valuing wildlife: Economic and social perspectives. Westview Press, Boulder, Colorado. 424 pp.

Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66:451-462.

Blundell, G. M., J. W. Kern, R. T. Bowyer, and L. K. Duffy. 1999. Capturing river otters: A comparison of Hancock and leg-hold traps. Wildlife Society Bulletin 27:184-192.

Boggess, E. K. 1994. Raccoons. Pp C101-C107 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Bomford, M. 1990. Ineffectiveness of a sonic device for deterring European Starlings. Wild. Soc. Bull. 18:151-156.

Borg, E. 1978. Physiological aspects of the effects of sound on man and animals. Acta Oto-laryngologica, Supplement 360:80-85.

Boyce, P. S. 1998. The social construction of bereavement: an application to pet loss. M.S. Thesis, University of New York. 1348 pp.

Brasheres, J. S., L. R. Prugh, C. J. Stoner, and C. W. Epps. 2010. Ecological and conservation implications of mesopredator release. Pages 221-240 in J. Terborgh and J. A. Estes, eds., Trophic Cascades: Predators, Prey and the Changing Dynamics of Nature, Island Press, Washington, D.C.

Bratton, S. P. 1975. The effect of the European wild boar (S*us scrofa*) on gray beech forest in the Great Smokey Mountains. Ecology 56:1356-1366.

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

Bromley, C. and E. M. Gese. 2001*b*. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Can. J. Zool. 79:386-392.

Burke, T. W., and W. F. Rowe. 1992. Bullet ricochet – a comprehensive review. Journal of Forensic Sciences 37:1254-1260.

Cain, S., A. Kadlec, D. L. Allen, R. A. Cooley, M. C. Hornocker, A. S. Leopold, and F. H. Wagner. 1972. Predator control-1971 report to the Council on Environmental Quality and the Department of the Interior by the Advisory Committee on Predator Control. Council on Environmental Quality and U.S. Department of the Interior, Washington, D.C., USA.

Camenzind, F. J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson Wyoming. Pp 267-294 *in* M. Bekoff, ed. Coyotes: biology, behavior and management. Academic Press, New York, New York.

Cardinale, B. J., J. E. Duffy, A. Gonzalez, D. U. Hooper, C. Perrings, P. Venail, A. Narwani, G. M. Mace, D. Tilman, D. A.Wardle, A. P. Kinzig, G. C. Daily, M. Loreau, J. B. Grace, A. Larigauderie, D. S. Srivastava, and S. Naeem. 2012. Biodiversity loss and its impact on humanity. Nature 486:59–67.

Castillo, D., and A. L. Clarke. 2003. Trap/neuter/release methods ineffective in controlling domestic cat “colonies” on public lands. Natural Areas Journal 23:247-253.

Caudell, J. N., B. C. West, B. Griffin, and K. Davis. 2009. Fostering greater professionalism with firearms in the wildlife arena. Proceedings of the Wildlife Damage Management Conference 13:95-99.

Caudell, J. N., S. R. Stopak, and P. C. Wolf. 2012. Lead-free, high-powered rifle bullets and their applicability in wildlife management. Human-Wildlife Conflicts. 6(1): 105-111.

Chamberlain, M. J., and B. D. Leopold. 2001. Omnivorous furbearers. Pp 278-292 *in* J. G. Dickson editor. Wildlife of southern forests: habitat and management. Hancock House Publishers, Blaine, Washington.

Chapman, J. A., and J. A. Litvaitis. 2003. Eastern cottontail. Pp 101-125 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Chavarria, P. M., R. R. Lopez, G. Bowser, and N. J. Silvy. 2007. A landscape-level survey of feral hog impacts to natural resources of the Big Thicket National Preserve. Human-Wildlife Conflicts 1:199–204.

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

Choquenot, D., J. McIlroy, and T. Korn. 1996. Managing vertebrate pests: feral pigs. Bureau of Resource Sciences, Australian Government Publishing Service, Canberra, ACT, Australia.

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

Conner, L. M., and G. Morris. 2015. Impacts of Mesopredator Control on Conservation of Mesopredators and their prey. PLoS ONE 10(9): e0137169

Connolly, G. E. 1978. Predator control and coyote populations: A review of simulation models. Pp 327-345 *in* M. Bekoff, ed. Coyotes: Biology, Behavior and Management. Academic Press, New York. 384 pp.

Connolly, G. E. 1992. Coyote damage to livestock and other resources. Pp 161-169 *in* A.H. Boer, ed. Ecology and management of the eastern coyote. Wildlife Research Unit. University of New Brunswick, Fredericton, New Brunswick, Canada.

Connolly, G. E. 1995. The effects of control on coyote populations: Another look. Symposium Proceedings—Coyotes in the Southwest: A Compendium of Our Knowledge (1995). Paper 36. http://digitalcommons.unl.edu/coyotesw/36. Accessed April 6, 2012.

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

Conomy, J. T., J. A. Dubovsky, J. A. Collazo, and W. J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance? Journal of Wildlife Management 62:1135-1142.

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

Conover, M. R., W. C. Pitt, K. K. Kessler, T. J. DuBow, and W. A. Sanborn. 1995. Review of human injuries, illness, and economic losses caused by wildlife in the United States. Wildlife Society Bulletin 23:407-414.

Corn, J. L., P. K. Swiderek, B. O. Blackburn, G. A. Erickson, A. B. Thiermann, and V. F. Nettles. 1986. Survey of selected diseases in wild swine in Texas. J. Am. Vet. Med. Assoc. 189:1029-1032.

Cote, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395-405.

Cox, R. R. And A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. Journal of Field Ornithology 65:551-555.

Craig, J. R., J. D. Rimstidt, C. A. Bonnaffon, T. K. Collins, and P. F. Scalon. 1999. Surface water transport of lead at a shooting range. Bulletin of Environmental Contamination and Toxicology 63:312-319.

Craven, S. R. 1994. Cottontail rabbits. Pp D75-D80 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Craven, S. R., and S. E. Hygnstrom. 1994. Deer. Pp D25-D40 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

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

Crawford, B. A., M. R. Pelton, and K. G. Johnson. 1993. Techniques to monitor relative abundance of coyotes in East Tennessee. Proceedings of Annual Conference, Southeastern Association of Fish and Wildlife Agencies 47:62-70.

Crooks, K. R., and M. E. Soule. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Letters to Nature. 400:563-566.

Crowe, D. M. 1975. A model for exploited bobcat populations in Wyoming. Journal of Wildlife Management 39:408-415.

Daniel, T. C., A. Muhar, A. Arnberger, O. Aznar, J. W. Boyd, K. M. a. Chan, R. Costanza, T. Elmqvist, C. G. Flint, P. H. Gobster, A. Gret-Regamey, R. Lave, S. Muhar, M. Penker, R. G. Ribe, T. Schauppenlehner, T. Sikor, I. Soloviy, M. Spierenburg, K. Taczanowska, J. Tam, and A. von der Dunk. 2012. Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences 109:8812–8819.

Danner, D. A., and N. S. Smith. 1980. Coyote home range, movement, and relative abundance near a cattle feedyard. Journal of Wildlife Management 44:484-487.

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

Davidson, W. R. 2006. Field manual of wildlife diseases in the southeastern United States. Third edition. The University of Georgia, Athens. 448 pp.

de Groot, R. S., M. A. Wilson, and R. M. J. Boumans. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41:393–408.

DeBenedetti, S. H. 1986. Management of feral pigs at Pinnacles National Monument: why and how. Proceedings of the conference on the conservation and management of rare and endangered plants. California Native Plant Society, Sacramento, California.

Decker, D. J., and G. R. Goff. 1987. Valuing Wildlife: Economic and Social Perspectives. Westview Press. Boulder, Colorado, 424 p.

Decker, D. J., and L. C. Chase. 1997. Human dimensions of living with wildlife – a management challenge for the 21st century. Wildlife Society Bulletin 28:4-15.

Deer Friendly. 2024. Mississippi deer population. Deer Friendly website: www.deerfriendly.com. Accessed August 7, 2024.

Delaney, D. K., T. G. Grubb, P. Beier, L. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

DeLiberto, T. J., E. M. Gese, F. F. Knowlton, J. R. Mason, M. R. Conover, L. Miller, R. H. Schmidt, and M. K. Holland. 1998. Fertility control in coyotes: is it a potential management tool? Proceedings of the Vertebrate Pest Conference 18:144-149.

DeVault, T. L., B. F. Blackwell, J. L. Belant, and M. J. Begier. 2017. Wildlife at airports. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Wildlife Damage Management Technical Series. 19 pp.

DeVos, J. C. and J. L. Smith. 1995. Natural mortality in wildlife populations. Intl. Assoc. of Fish and Wildlife Agencies, Washington, D.C. 50 pp.

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

Dill, H. H. and W. H. Thornberry. 1950. A cannon-projected net trap for capturing waterfowl. Journal of Wildlife Management 14:132-137.

Dolbeer, R. A. 1998. Population dynamics: the foundation of wildlife damage management for the 21st century. Proc. 18th Vertebr. Pest Conf., Davis, CA, Pp. 2-11.

Dolbeer, R. A. 2000. Birds and aircraft: fighting for airspace in crowded skies. Proceedings of the Vertebrate Pest Conference 19:37-43.

Dolbeer, R.A. 2009. Birds and aircraft: fighting for airspace in ever more crowded skies. Human-Wildlife Conflicts 3:165-166.

Dolbeer, R. A., G. E. Bernhardt, T. W. Seamans and P. P. Woronecki. 1991. Efficacy of two gas cartridge formulations in killing woodchucks in burrows. Wildlife Society Bulletin 19:200-204.

Dolbeer, R. A., P. P. Woronecki, and R. L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. Wildlife Society Bulletin 14:418-425.

Dolbeer, R. A., M. J. Begier, P. R. Miller, J. R. Weller, and A. L. Anderson. 2024. Wildlife strikes to civil aircraft in the United States 1990 – 2023. Serial Report 30. United States Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C.

Donaldson, C. W. 2003. Paintball toxicosis in dogs. Veterinary Medicine 98(12): 995-997.

Doupe, R. G., J. Mitchell, M. J. Knott, A. M. Davis, and A. J. Lymbery. 2010. Efficacy of exclusion fencing to protect ephemeral floodplain lagoon habitats from feral pigs. Wetlands Ecology Management 18:69-78.

Dutcher, A., K. Plas, G. Sizemore, and S. M. Vantassel. 2021. Free-ranging and feral cats. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. Wildlife Damage Management Technical Series. 25 pp.

Ellis, D. H. 1981. Responses of Raptorial Birds to low level military jets and sonic booms: Results of the 1980-1981 Joint U.S. Air Force-U.S. Fish and Wildlife Service Study. Prepared by the Institute for Raptor Studies for USAF and USFWS. NTIS No. ADA 108-778.

Engeman, R. M., A. Stevens, J. Allen, J. Dunlap, M. Daniel, D. Teague, and B. Constantin. 2007. Feral swine management for conservation of an imperiled wetland habitat: Florida's vanishing seepage slopes. Biological Conservation 134:440–446.

Engeman, R. M., A. Duffiney, S. Braem, C. Olsen, B. Constantin, P. Small, J. Dunlap, and J. C. Griffin. 2010. Dramatic and immediate improvements in insular nesting success for threatened sea turtles and shorebirds following predator management. Journal of Experimental Marine Biology and Ecology 395:147-152.

EPA. 1991. Reregistration eligibility document: Inorganic nitrate/nitrite (sodium and potassium nitrates). List D, Case 4052. Environmental Protection Agency, Office of Pesticide Programs Special Review and Reregistration Division, Washington, D.C.

EPA. 2000. Introduction to phytoremediation. EPA/600/R-99/107, Office of Research and Development, Washington, D.C.

EPA. 2001. Selected mammal and bird repellents fact sheet. https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_G-112_01-Mar-01.pdf. Accessed November 18, 2024.

EPA. 2009. Pesticide fact sheet: Mammalian Gonadotropin releasing hormone (GnRH). United States Environmental Protection Agency, Office of Prevention, Pesticides, and Toxic Substances. Arlington, Virginia.

Errington, P. L. 1933. Bobwhite winter survival in an area heavily populated with grey fox. Iowa State College Journal of Science 8:127–130.

Estes, J. A., J. Terborgh, J. S. Brashares, M. E. Power, J. Berger, W. J. Bond, S. R. Carpenter, T. E. Essington, R. D. Holt, J. B. C. Jackson, R. J. Marquis, L. Oskanen, T. Oskanen, R. T. Paine, E. K. Pikitch, W. J. Ripple, S. A. Sandin, M. Scheffer, T. W. Schoener, J. B. Shurin, A. R. E. Sinclair, M. E. Soule, R. Virtanen, and D. A. Wardle. 2011. Trophic downgrading of planet earth. Science 333:301–307.

Etter, D. R., and J. L. Belant. 2011. Evaluation of 2 cable restraints with minimum loop stops to capture coyotes. Wildlife Society Bulletin 35:403–408.

Fairaizl, S. D., and W. K. Pfeifer. 1988. The lure crop alternative. Great Plains Wildl. Damage Cont. Workshop 8:163-168.

Fancy, S. G. 1982. Reaction of bison to aerial surveys in interior Alaska. Canadian Field Naturalist 96:91.

Federal Aviation Administration. 2024. Wildlife strike database website. https://wildlife.faa.gov/home. Accessed May 10, 2024.

Fedriani, J. M., T. K. Fuller, and R. M. Sauvajot. 2001. Does availability of anthropogenic food enhance densities of omnivorous mammals? An example with coyotes in southern California. Ecography 24:325-331.

Fergus, C. 2006. Cottontail rabbit. Wildlife Note – 4, LDR0103. Pennsylvania Game Commission, Bureau of Information and Education, Harrisburg, Pennsylvania.

Fitzwater, W. D. 1994. Feral house cats. Pp C45-50 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Frank, D. A. 2008. Evidence for top predator control of a grazing ecosystem. Oikos 117:1718-1724.

Fraser, D. J., F. Gardner, G. B. Kolenosky, and S. Strathern. 1982. Estimation of harvest rate of black bears from age and sex data. Wildlife Society Bulletin 10:53-57.

Fraser, J. D., L. D. Frenzel, and J. E. Mathisen. 1985. The impact of human activities on breeding bald eagles in north-central Minnesota. Journal of Wildlife Management 49:585-592.

Fritzell, E. K. 1987. Gray fox and island fox. Pp 408-420 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Fuller, T. K., W. E. Berg, and D. W. Kuehn. 1985. Survival rates and mortality factors of adult bobcats in north-central Minnesota. Journal of Wildlife Management 49:292-296.

Fuller, M. R., and J. A. Mosher. 1987. Raptor survey techniques. Pp. 37-65 *in* B. A. Giron Pendleton, B. A. Millsap, K. W. Cline, and D. M. Bird, eds. Raptor management techniques manual. National Wildlife Federation, Washington, D.C.

Fuller, W. A. 1969. Changes in number of three species of small rodents near Great Slave Lake, Northwest Territories, Canada, 1964-1967 and their significance for general population theory. Annales Zoologici Fennici 6:113-144.

Fuller-Perrine, L. D., and M.E. Tobin. 1993. A method for applying and removing bird exclusion netting in commercial vineyards. Wildlife Society Bulletin 21:47-51.

Gardner, A. L., and M. E. Sunquist. 2003. Opossum. Pp 3-29 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Gardner, C. L. 2010. Reducing nontarget moose capture in wolf snares. Alces 46:167-182.

Garmestani, A. S., and H. F. Percival. 2005. Raccoon removal reduces sea turtle nest predation in the Ten Thousand Islands of Florida. Southeastern Naturalist 4:469–472.

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

Gehring, T. M., K. C. VerCauteren, M. L. Provost, and A. C. Cellar. 2010*a*. Utility of livestock-protection dogs for deterring wildlife from cattle farms. Wildlife Research 37:715-721.

Gehrt, S. D. 2003. Raccoon. Pp 611-634 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Gerwolls, M. K., and S. M. Labott. 1994. Adjustment to the death of a companion animal. Anthrozoos 7:172-187.

Gese, E. M. 1998. Response of neighboring coyotes (*Canis latrans*) to social disruption in an adjacent pack. Canadian Journal of Zoology 76:1960-1963.

Gese, E. M. 2005. Demographic and Spatial Responses of Coyotes to Changes in Food and Exploitation. Pages 271–285 in. D. L. Nolte, and K. A. Fagerstone, eds., Proceedings of the 11th Wildlife Damage Management Conference.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1988. Home range and habitat use of coyotes in southeastern Colorado. Journal of Wildlife Management 52:640-646.

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

Gier, H. T. 1948. Rabies in the wild. Journal of Wildlife Management 12:142–153.

Gier, H. T. 1968. Coyotes in Kansas. Rev. ed. Kansas State Coll., Agric. Exp. Stn. Bull. 393. 118 pp.

Gill, J. L., J. W. Williams, S. T. Jackson, K. B. Lininger, and G. S Robinson. 2009. Pleistocene megafaunal collapse, novel plant communities and enhanced fire regimes in North America. Science 326:1100-1103.

Gilmer, D. S., L. M. Cowardin, R. L. Duval, L. M. Mechlin, C. W. Shaiffer, and V. B. Kuechle. 1981. Procedures for the use of aircraft in wildlife biotelemetry studies. U.S. Fish and Wildlife Service Resource Publication 140.

Gionfriddo, J. P., A. J. Denicola, L. A. Miller, and K. A. Fagerstone. 2011. Health effects of GnRH immunocontraception of wild white-tailed deer in New Jersey. Wildlife Society Bulletin 35:149-160.

Gionfriddo, J. P., J. D. Eisemann, K. J. Sullivan, R. S. Healey, L. A. Miller, K. A. Fagerstone, R. M. Engeman, and C. A. Yoder. 2009. Field test of single-injection gonadotrophin-releasing hormone immunocontraceptive vaccine in female white-tailed deer. Wildlife Research 36:177-184.

Gladwin, D. N., D. A. Asherin, and K. M. Manci. 1988. Effects of aircraft noise and sonic booms on fish and wildlife. U.S. Fish and Wildlife Service National Ecology Research Center Report 88/30.

Glow, M. P., N. P. Snow, and K. C. VerCauteren. 2020. Feral swine. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Wildlife Damage Management Technical Series. 21 pp.

Goldburg, R. J., M. S. Elliot, and R. L. Naylor. 2001. Marine aquaculture in the United States. Prepared for the Pew Oceans Commission. https://www.pewtrusts.org/-/media/legacy/uploadedfiles/wwwpewtrustsorg/reports/protecting_ocean_life/envpewoceansaquaculturepdf.pdf. Accessed November 18, 2024.

Gosling, M., Baker, S. J. and C. N. Clarke. 1988. An attempt to remove coypus (*Myocastor coypus*) from a wetland habitat in East Anglia. J. Appl. Ecol. 25: 49-62.

Green, J. S., and P. S. Gipson. 1994. Feral dogs. Pp C77-C82 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

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

Green, J. S., and R. A. Woodruff. 1988. Breed comparisons and characteristics of use of livestock guarding dogs. Journal of Range Management 41:249-251.

Green, J. S., F. R. Henderson, and M. D. Collinge. 1994. Coyotes. Pp. C51-C76 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Greenhall, A. M., and S. C. Frantz. 1994. Bats. Pp D5-D24 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-bearing mammals of California. 2 vols. Univ. California Press, Berkeley. 777 pp.

Grubb, T. G., D. K. Delaney, W. W. Bowerman, and M. R. Wierda. 2010. Golden eagle indifference to heli-skiing and military helicopters in Northern Utah. Journal of Wildlife Management 74:1275–1285.

Gunderson, L. H. 2000. Ecological resilience - In theory and application. Annual Review of Ecology and Systematics 31:425-439.

Guthery, F. S. and S. L. Beasom. 1977. Responses of game and nongame wildlife to predator control in South Texas. J. Range Manage. 30:404-409.

Hallberg, D. L., and G. R. Trapp. 1984. Gray fox temporal and spatial activity in a riparian–agricultural zone in California's Central Valley. Pp 920-928 *in* R. E. Warner and K. M. Hendrix, eds. Proceedings of the California Riparian Systems Conference. University of California Press, Berkeley, California.

Hamilton, D. A. 1982. Ecology of the bobcat in Missouri. M. S. Thesis, Univ. Missouri, Columbia, Missouri. 132 pp.

Hamrick, B., M. Smith, C. Jaworowski, and B. Strickland. 2011. A landowner's guide for wild pig management: Practical methods for wild pig control. Mississippi State University Extension Service and Alabama Cooperative Extension System.

Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (*Vulpes vulpes*) population. Mammal Rev. 7:25-39.

Harris, S, and J. M. V. Rayner. 1986. Urban fox (*Vulpes vulpe*s) population estimates and habitat requirements in several British cities. J. Anim. Ecol. 55:575–591.

Haulton, S. M., W. F. Porter, and B. A. Rudolph. 2001. Evaluating 4 methods to capture white-tailed deer. Wildlife Society Bulletin 29:255-264.

Hawkins, R. E., L. D. Martoglio, and G. G. Montgomery. 1968. Cannon-netting deer. Journal of Wildlife Management 32:191-195.

Haygood, J. 2022. How much fuel does a Cessna 182 burn per hour? June 20, 2023. https://www.skytough.com/post/cessna-182-fuel-per-hour#:~:text=The%20Cessna%20182%20burns%2013.8%20gallons%20of%20fuel,which%20provides%20a%20maximum%20range%20of%201%2C200%20miles. Accessed December 2, 2024.

Henke, S. E. 1992. Effect of coyote removal on the faunal community ecology of a short-grass prairie. Ph.D. Thesis., Tex. Tech Univ., Lubbock. 229 pp.

Henke, S. E. 1995. Effects of coyote control on their prey: A review. In (Proceedings) Coyotes in the Southwest: A Compendium of our Knowledge. December 1995. Tex. Agric. Ext. Serv., Tex. A&M Univ. San Angelo, Texas. Pp. 35-40.

Henke, S. E., and F. C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. Journal of Wildlife Management 63:1066–1081.

Highskyflying. 2023. How Much Fuel Does a Helicopter Use? (With Statistics!). September 26, 2023. https://www.highskyflying.com/how-much-fuel-does-a-helicopter-use-with-statistics/. Accessed December 2, 2024.

Holthuijzen, A. M. A., W. G. Eastland, A. R. Ansell, M. N. Kochert, R. D. Williams, and L. S. Young. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270-281.

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

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

Hunt, W. G., R. T. Watson, J. L. Oaks, C.N. Parish, K. K. Burnham, R. L. Tucker, J. R. Belthoff, and G. Hart. 2009. Lead bullet fragments in venison from rifle-killed deer: Potential for human dietary exposure. PLoS ONE 4(4):e5330.

International Association of Fish and Wildlife Agencies. 2005. The potential costs of losing hunting and trapping as wildlife management tools. Animal Use Committee, International Association of Fish and Wildlife Agencies, Washington, D.C. 46 pp.

Iossa, G., C. D. Soulsbury, and S. Harris. 2007. Mammal trapping: a review of animal welfare standards of killing and restraining traps. Animal Welfare 16:335-352.

Isaksson, D., J. Wallander, and M. Larsson. 2007. Managing predation on groundnesting birds: The effectiveness of nest exclosures. Biological Conservation 136:136–142.

Jessup, D.A. 2004. The welfare of feral cats and wildlife. Journal of the American Veterinary Medical Association 225:1377-1382.

Johansen, P., G. Asmund, and F. Riget. 2004. High human exposure to lead through consumption of birds hunted with lead shot. Environmental Pollution 127:125–129.

Johnson, M., and L. W. Orning. 2002. Are nest exclosures an effective tool in plover conservation? Waterbirds 25:184–190.

Johnson, S. R., S. T. Deliberto, K. Urchek, A. T. Gilbert, and S. J. Werner. 2022. Concentration-response of an anthraquinone-based repellent for raccoons (*Procyon lotor*). Applied Animal Behaviour Science 251:105628. doi: 10.1016/j.applanim.2022.105628.

Jojola, S., G. Witmer, and P. Burke. 2009. Evaluation of attractants to improve trapping success of nutria on Louisiana coastal marsh. USDA National Wildlife Research Center - Staff Publications. Paper 929. http://digitalcommons.unl.edu/icwdm_usdanwrc/929.

Jones, S. C., and K. K. Jordan. 2004. Extension Fact Sheet: Bat Bugs. The Ohio State University Extension. HYG-2105A-05. 4 pp.

Jones, J. M. and J. H. Witham. 1990. Post-translocation survival and movements of metropolitan white-tailed deer. Wildlife Society Bulletin 18:434-441.

Kaller, M. D., and W. E. Kelso. 2003. Effects of feral swine on water quality in a coastal bottomland stream. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 57: 291-298.

Kaller, M. D., and W. E. Kelso. 2006. Swine activity alters invertebrate and microbial communities in a coastal watershed. The American Midland Naturalist 156: 165-179.

Kamler, J. F., C. Richardson, and P. S. Gipson. 2000. Comparison of standard and modified Soft Catch traps for capturing coyotes, bobcats, and raccoons. Proc. Wildl. Dam. Manage. Conf 9:77–84.

Kamler, J. F., N. F. Jacobsen, and D. W. MacDonald. 2008. Efficiency and safety of Soft Catch traps for capturing black-backed jackals and excluding non-target species. South African Journal of Wildlife Research 38(2):113-116.

Kamler, J. F., W.B. Ballard, R. L. Gilliland, and K. Mote. 2002. Improved trapping methods for swift foxes and sympatric coyotes. Wildl. Soc. Bull 30:1262–1266.

Katzner, T. E., D. J. Pain, M. McTee, L. Brown, S. Cuadros, M. Pokras, V. A. Slabe, R. T. Watson, G. Wiemeyer, B. Bedrosian, J. O. Hampton, C. N. Parish, J. M. Pay, K. Saito, and J. H. Shulz. 2024. Lead poisoning of raptors: State of the science and cross-discipline mitigation options for a global problem. Biological Reviews 99:1672-1699. doi: 10.1111/brv.13087.

Kays, R. 2018. *Canis latrans* (errata version published in 2020). The IUCN Red List of Threatened Species 2018: e.T3745A163508579. https://dx.doi.org/10.2305/IUCN.UK.2018- 2.RLTS.T3745A163508579.en.

Keirn, G., J. Cepek, B. Blackwell, and T. DeVault. 2010. On a quest for safer skies: managing the growing threat of wildlife hazards to aviation. The Wildlife Professional, Summer 2010: 52-55.

Keith, L. B. 1963. Wildlife's ten-year cycle. University of Wisconsin Press, Madison, Wisconsin. 201 pp.

Keith, L. B. 1974. Some features of population dynamics in mammals. International Congress on Game Biology 11:17-59.

Kendall, R. J., T. E. Lacher Jr., C. Bunck, F. B. Daniel, C. Driver, C. E. Grue, F. Leighton, W. Stansley, P. G. Watanabe, and M. Whitworth. 1996. An ecological risk assessment of lead shot exposure in non-waterfowl avian species: upland game birds and raptors. Environmental Toxicology and Chemistry 15:4-20.

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

Kern, W. H., Jr. 2002. Raccoons. WEC-34. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

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

Kirsch, E. M. 1996. Habitat selection and productivity of least terns on the lower Platte River, Nebraska. Wildlife Monograph 132:1-48.

Knopff, K. H., A. A. Knopff, and M. S. Boyce. 2010. Scavenging makes cougars susceptible to snaring at wolf bait stations. Journal of Wildlife Management 74:644-653.

Knowlton, F. F. 1964. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Dissertation, Purdue University, Lafayette, Illinois, USA.

Knowlton, F. F. 1972. Preliminary interpretations of coyote population mechanics with some management implications. Journal of Wildlife Management 36:369-383.

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

Koh, L. P., and S. A. Wich. 2012. Dawn of drone ecology: low-cost autonomous aerial vehicles for conservation. Tropical Conservation Science 5(2):121-132.

Kolbe, J. A., Squires, J. R. and T. W. Parker. 2003. An effective box trap for capturing lynx. Wildlife Society Bulletin 31:980-985.

Kolenosky, G. B., and S. M Strathearn. 1987. Black Bear. Pp 443-454 *in* M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds. Wild Furbearer Management and Conservation in North America. 1150 pp.

Kosnett, M. J. 2009. Health effects of low dose lead exposure in adults and children, and preventable risk posed by the consumption of game meat harvested with lead ammunition. In R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt (eds.). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI 10.4080/ilsa.2009.0103.

Krausman, P. R., and J. J. Hervert. 1983. Mountain sheep responses to aerial surveys. Wildlife Society Bulletin 11:372-375.

Krausman, P. R., L. K. Harris, C. L. Blasch, K. K. G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs 157.

Krausman, P. R., B. D. Leopold, and D. L. Scarborough. 1986. Desert mule deer responses to aircraft. Wildlife Society Bulletin 13:71-73.

Krebs, C. J., R. Boonstra, S. Boutin, and A. R. E. Sinclair. 2001. What drives the 10-year cycle of snowshoe hares? Bioscience 51:25-35.

Kreeger, T. J., and J. M. Arnemo. 2012. Handbook of wildlife chemical immobilization. Fourth edition. Wildlife Pharmaceuticals, Inc., Fort Collins, Colorado, USA.

Kreeger, T. J., P. J. White, U. S. Seal, and J. R. Tester. 1990. Pathophysiological Responses of Red Foxes to Foothold Traps. Journal of Wildlife Management 54:147-160.

KuKanch, B., and A. J. Wiese. 2015. Opioids. Pages 207 – 226 *in* K. A. Grimm, L. A. Lamont, W. J. Tranquilli, S. A. Green, and S. A. Robertson, editors. Veterinary anesthesia and analgesia: The fifth edition of Lumb and Jones. Wiley Blackwell, Ames, Iowa, USA.

Kushlan, J. A. 1979. Effects of helicopter censuses on wading bird colonies. Journal of Wildlife Management 43:756-760.

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

Lamp, R. E. 1989. Monitoring of the effect of military air operations at naval air station Fallon on the biota of Nevada. Nevada Department of Wildlife, Reno, Nevada.

Lancia, R. A., C. S. Rosenberry, and M. C. Conner. 2000. Population parameters and their estimation. Pp 64-83 *in* S. Demaris and P. R. Krausman, eds. Ecology and management of large mammals in North America. Prentice-Hall Incorporated, Upper Saddle River, New Jersey.

Larkin, R. P., T. R. VanDeelen, R. M. Sabick, T. E. Gosselink, and R. E. Warner. 2003. Electronic signaling for prompt removal of an animal from a trap. Wildlife Society Bulletin 31:392-398.

Latham, R. M. 1960. Bounties Are Bunk. Nat. Wildl. Federation, Wash., D.C. 10 pp.

Lawhead, D. N. 1984. Bobcat (*Lynx rufus*) home range, density and habitat preference in South-Central Arizona. The Southwestern Naturalist 29:105-113.

Layne, J. N. 2003. Armadillo. Pp 75-97 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Lefrancois, G. R. 1999. The Lifespan. Sixth edition. Wadsworth Publishing Company, Belmont, California. 556 pp.

Lembeck, M. 1978. Bobcat study, San Diego County, California. Calif. Dep. Fish and Game, Fed. Aid Nongame Wildl. Invest. Proj. E-W-2, Rep. 22 pp.

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

Levy, J. K., and P. C. Crawford. 2004. Humane strategies for controlling feral cat populations. Journal of the American Veterinary Medical Association 225:1354-60.

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

Linhart, S. B., G. J. Dasch, R. B. Johnson, J. D. Roberts, and C. J. Packham. 1992. Electronic frightening devices for reducing coyote predation on domestic sheep: Efficacy under range conditions and operational use. Pages 386-392 *in* J. E. Borrecco and R. E. Marsh, eds., Proceedings of the 15th Vertebrate Pest Conference. University of California-Davis, Davis, California.

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

Linnell, M. A., M. R. Conover, and T. J. Ohashi. 1996. Analysis of bird strikes at a tropical airport. Journal of Wildlife Management 60:935-945.

Lord, R. D., Jr. 1961. A population study of the gray fox. Am. Midl. Nat. 66:87–109. Sci. 38.79–82.

Lovallo, M. J., H. B. White, J. D. Erb, M. S. Peek, T. J. Deliberto. 2021. Welfare performance of three foothold traps for capturing North American river otters Lontra canadensis. Journal of Fish and Wildlife Management 12:1-7.

Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2000. 100 of the world's worst invasive alien species; a selection from the global invasive species database. Published by The Invasive Species Specialist Group (ISSG), a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN). 12 pp. First published as special lift-out in *Aliens 12*, December 2000. Updated and reprinted version: November 2004.

Lyons, M., K. Brandis, C. Callaghan, J. McCann, C. Mills, S. Ryall, and R. Kingsford. 2017. Bird interactions with drones, from individuals to large colonies. BioRxiv, p.109926.

MacDonald, D. W., and M. T. Newdick. 1982. The distribution and ecology of fox, *Vulpes vulpes* (L.), in urban areas. Pages 123–135 in R. Bornkamm, J. A. Lee, and M. R. D. Seaward, Eds., *Urban ecology*. Blackwell Sci. Publ., Oxford, United Kingdom.

MacKinnon, B., R. Sowden, and S. Dudley. 2004. Sharing the skies: an aviation guide to the management of wildlife hazards. Transport Canada, Aviation Publishing Division, AARA, 5th Floor, Tower C, 330 Sparks Street, Ottawa, Ontario, K1A 0N8, Canada.

MacPherson, D. 2005. Bullet Penetration: Modeling the dynamics and the incapacitation resulting from wound trauma. Ballaistic Publications. El Segundo, CA.

Manci, K. M., D. N. Gladwin, R. Villella, and M. G. Cavendish. 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: A literature synthesis. Fort Collins, Colorado/ Kearneysville, West Virginia. U.S. Fish and Wildlife Service and National Ecology Research Center.

Marks, S. G., J. E. Koepke, and C. L. Bradley. 1994. Pet attachment and generativity among young adults. Journal of Psychology 128:641.

Maron, J. L., and D. E. Pearson. 2011. Vertebrate predators have minimal cascading effects on plant production or seed predation in an intact grassland ecosystem. Ecology Letters 14:661–669.

Martin, J., H. H. Edwards, M. A. Burgess, H. F. Percival, D. E. Fagan, B. E. Gardner, J. G. Ortega-Ortiz, P. G. Ifju, B. S Evers, T. J. Rambo. 2012. Estimating distribution of hidden objects with drones: From tennis balls to manatees. PLoS ONE 7(6): e38882. doi:10.1371/journal.pone.0038882.

Massey, B. W. 1971. A breeding study of the California least tern, 1971. Administrative Report 71-9, Wildlife Management Branch, California Department of Fish and Game.

Massey, B. W., and J. L. Atwood. 1981. Second-wave nesting of the California least tern: age composition and reproductive success. Auk 98:596-605.

Matschke, G. H., and K. A. Fagerstone. 1984. Efficacy of a two-ingredient fumigant on Richardson's ground squirrels. Proc. Vertebr. Pest Conf. 11:17-19.

Mayer, J. J., and I. L. Brisbin, Jr., eds. 2009. Wild Pigs: Biology, Damage, Control Techniques and Management. SRNLRP-2009-00869. Savannah River National Laboratory, Aiken, South Carolina.

Mayer, J. J., and P. E. Johns. 2007. Characterization of Wild Pig-Vehicle Collisions. Proceedings of the Wildlife Damage Management Conference 12:175-187.

McClure, M. F., Smith, N. S. and Shaw, W. W. 1996. Densities of coyotes at the interface of Saguaro National monument, and Tucson, Arizona. Southwest Naturalist 41: 83–86.

McClure, M. L., C. L. Burdett, M. L. Farnsworth, S. J. Sweeney, and R. S. Miller. 2018. A globally-distributed alien invasive species poses risks to United States imperiled species. Scientific Reports 8:5331 DOI:10.1038/s41598-018-23657-z.

McDonough, M. T., S. S. Ditchkoff, M. D. Smith, and K. C. Vercauteren. 2022. A review of the impacts of invasive wild pigs on native vertebrates. Mammalian Biology 102:279-290.

McKnight, T. 1964. Feral livestock in Anglo-America. University of California Publications in Geography Vol. 16. University of California Press, Berkeley, California.

Melquist, W. E., and A. E. Dronkert. 1987. River otter. Pp 626-641 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Melquist, W. E., P. J. Polechla, Jr., and D. Toweill. 2003. River otter. Pp 708-734 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Mengak, M. T. 2005. Nine-banded Armadillo (*Dasypus novemcinctus*). Warnell School of Forest Resources Natural History Series No. 4, May 2005.

Mersinger, R. C., and N. J. Silvy. 2007. Range size, habitat use and dial activity of feral hogs on reclaimed surface-mined lands in east Texas. Human–Wildlife Conflicts 1:161–167.

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

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

Meyers, B. 2000. Anticipatory mourning and the human-animal bond. Pp 537-564 *in* T. A. Rando, ed. Clinical dimensions of anticipatory mourning: theory and practice in working with the dying, their loved ones, and their caregivers. Research Press, Champaign, Illinois.

Mich, P. M., L. L. Wolfe, T. M. Sirochman, M. A. Sirochman, and T. R. Davis. 2007. Evalustion of intramuscular butorphanol, azaperone, and medetonmidine and nasal oxygen insufflation for chemical immobilization of white-tailed deer, Odocoileus virginianus. Journal of Zoology and Wildlife Medicine. 39: 480-487.

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

Miller, K. V., L. I. Muller, and S. Demarais. 2003. White-tailed deer. Pp 906-930 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Miller, L. A. 1995. Immunocontraception as a tool for controlling reproduction in coyotes. Pp 172-176 *in* D. Rollins, C. Richardson, T. Blankenship, K. Canon, and S. Henke, eds. Coyotes in the Southwest: A Compendium of Our Knowledge. Proc. of a Symposium, Dec. 13-15, Texas A&M University, San Angelo, Texas.

Miller, L. A., B. E. Johns, and G. J. Killian. 2000. Immunocontraception of white-tailed deer with GnRH vaccine. American Journal of Reproductive Immunology 44:266-274.

Mississippi Museum of Natural Science. 2015. Mississippi State Wildlife Action Plan. Mississippi Department of Wildlife, Fisheries, and Parks, Mississippi Museum of Natural Science, Jackson, Mississippi. 704 pp.

Mississippi State Department of Health. 2018. Rabies. Mississippi Department of Health website: https://msdh.ms.gov/page/14,0,142.html. Accessed November 18, 2024.

Mississippi Department of Environmental Quality. 2022. State of Mississippi water quality assessment 2022 Section 305(b) report. Office of Pollution Control, Field Services Division, Jackson, Mississippi. 243 pp.

Mississippi State University Extension. 2024. White-tailed deer. Mississippi State University Extension website: http://extension.msstate.edu/natural-resources/wildlife/white-tailed-deer. Accessed November 18, 2024.

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

Mott, M. 2004. United States faces growing feral cat problem. National Geographic News 596.

Mowat, G., Slough, B.G., and R. E. Rivard. 1994. A comparison of three live capturing devices for lynx: capture efficiency and injuries. Wildlife Society Bulletin 22:644-650.

Muller, L. I., R. J. Warren, and D. L. Evans. 1997. Theory and Practice of immunocontraception in wild animals. Wildlife Society Bulletin 25:504-514.

Munoz-Igualada, J., Shivik, J. A., Dominguez, F. G., Lara, J. and L. M. Gonzalez. 2008. Evaluation of Cage-Traps and Cable Restraint Devices to Capture Red Foxes in Spain. Journal of Wildlife Management 3:830-836.

Myers, J. H., and C. J. Krebs. 1971. Genetic, behavioral, and reproductive attributes of dispersing field voles *Microtus pennsylvanicus* and *Microtus ochrogaster*. Ecological Monographs 41:53-78.

Naiman, R. J., and K. H. Rogers. 1997. Large animals and system-level characteristics in river corridors. BioScience 47:521–529.

NASS. 2002. U.S. Wildlife Damage. U.S. Dept. Agric., Natl. Agric. Statistics Serv., Washington, D.C.

NASS. 2011. Cattle death loss 2010. United States Department of Agriculture, National Agricultural Statistics Service, Washington, D.C. 17 pp.

NASS. 2017. Cattle and Calves Death Loss in the United States Due to Predator and Nonpredator Causes, 2015. United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, Centers for Epidemiology and Animal Health, Fort Collins, Colorado. 85 pp.

National Marine Fisheries Service and United States Fish and Wildlife Service. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. National Marine Fisheries Service, Silver Spring, Maryland.

National Park Service. 1995. Report of effects of aircraft overflights on the National Park System. USDI-NPS D-1062, July 1995.

Neff, D. J., R. H. Smith, and N. G. Woolsey. 1985. Pronghorn antelope mortality study. Final Report, Federal Aid to Wildlife Restoration Project W-78-R, Arizona Game and Fish Department, Phoenix, Arizona, USA.

Neuman, K. K., G. W. Page, L. E. Stenzel, J. C. Warriner, and J. S. Warriner. 2004. Effect of mammalian predator management on Snowy Plover breeding success. Waterbirds 27: 257–263.

Nielsen, C. K., and A. Woolf. 2001. Spatial organization of bobcats (*Lynx rufus*) in southern Illinois. American Midland Naturalist 146:43–52.

Nielsen, L. 1988. Definitions, considerations, and guidelines for translocation of wild animals. Pages 12-49 *in* L. Nielsen and R. D. Brown, editors. Translocation of wild animals. Wisconsin Humane Society, Milwaukee, Wisconsin, and Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.

Nol, E., and R. J. Brooks. 1982. Effects of predator exclosures on nesting success of killdeer. Journal of Field Ornithology 53:263–268.

Nunley, G. L. 1995. The re-establishment of the coyote in the Edwards Plateau of Texas. Pages 55-64 in D. Rollins, T. Blankenship, S. Henke and K. Canon, editors, Proc. Coyotes in the Southwest: A compendium of our knowledge. San Angelo, Texas.

Organ, J. F., S. P. Mahoney, and V. Geist. 2010. Born in the hands of hunters: The North American model of wildlife conservation. The Wildlife Professional 4:22-27.

Organ, J. F., T. Decker, J. DiStefano, K. Elowe, P. Rego, and P. G. Mirick. 1996. Trapping and furbearer management: Perspectives from the Northeast. USDI-Fish and Wildlife Service, Hadley, Massachusetts.

Organ, J. F., V. Geist, S. P. Mahoney, S. Williams, P. R. Krausman, G. R. Batcheller, T. A. Decker, R. Carmichael, P. Nanjappa, R. Regan, R.A. Medellin, R. Cantu, R. E. McCabe, S. Craven, G. M. Vecellio, and D. J. Decker. 2012. The North American Model of

Wildlife Conservation. The Wildlife Society Technical Review 12-04. The Wildlife Society, Bethesda, Maryland, USA.

Pagel, M. D., R. M. May, and A. R. Collie. 1991. Ecological aspects of the geographical distribution and diversity of mammalian species. Am. Nat. 137:791-815.

Pain, D. J., I. J. Fisher, and V. G. Thomas. 2009. A global update of lead poisoning in terrestrial birds from ammunition sources. *In* R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt (Eds.). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI 10.4080/ilsa.2009.0108

Pain, D.J., R.L. Cromie, J. Newth, M.J. Brown, E. Crutcher, P. Hardman, L. Hurst, R. Mateo, A.A. Meharg, A.C. Moran, A. Raab, M.A. Taggart, and R.E. Green. 2010. Potential Hazard to Human Health from Exposure to Fragments of Lead Bullets and Shot in the Tissues of Game Animals. PLoS One 5(4):e10315. 17 pp.

Parker, G. 1995. Eastern coyote: The story of its success. Nimbus Publishing, Halifax, Canada.

Pelton, M. R. 2003. Black bear. Pp 547-555 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Perry, R.W. 2013. White-Nose Syndrome in Bats: An Overview of Current Knowledge for Land Managers. United States Department of Agriculture Forest Service Research & Development Southern Research Station Gen. Tech. Rep. SRS-184

Phillips, R. B., and C. S. Winchell. 2011. Reducing nontarget recaptures of an endangered predator using conditioned aversion and reward removal. J. Appl. Ecol. 48:1501–1507.

Phillips, R. L. 1996. Evaluation of 3 types of snares for capturing coyotes. Wildlife Society Bulletin 24: 107-110.

Phillips, R. L., and R. H. Schmidt. 1994. Fox. Pp C83-C88 *in* S. E. Hygnstrom, R. M. Timm and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Pitelka, F. A. 1957. Some characteristics of microtine cycles in the artic. Oregon State College, Biological Colloquium Proceedings 18:73-88.

Pitt, W. C., F. F. Knowlton, and P. W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model: preliminary results. End. Spp. Update 18:103-106.

Pitt, W. C., P. W. Box, and F. F. Knowlton. 2003. An individual-based model of canid populations: modelling territoriality and social structure. Ecological Modelling 166:109-121.

Polis, G. A., C. A. Myers, and R. D. Holt. 1989. The ecology and evolution of intraguild predation: potential competitors that eat each other. Annual Review of Ecology and Systematics 20:297–330.

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

Powell, R. A., and G. Proulx. 2003. Trapping and marking terrestrial mammals for research: integrating ethics, performance criteria, techniques, and common sense. ILAR Journal 44:259-276.

Proulx, G., D. Rodtka, M.W. Barrett, M. Cattet, D. Dekker, E. Moffatt and R.A. Powell. 2015. Humaneness and selectivity of killing neck snares used to capture canids in Canada: A review. Canadian Wildlife Biology and Management 4 (1): 55-65.

Prugh, L. R., C. J. Stoner, C. W. Epps, W. T. Bean, W. J. Ripple, A. S. Laliberte, and J. S. Brashares. 2009. The rise of the mesopredator. BioScience 59:779–791.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Minnesota. Journal of Wildlife Management 48:679-690.

Ramsey, C. W. 1968. A drop-net deer trap. Journal of Wildlife Management 32:187-190.

Reidinger, R. F., and J. E. Miller. 2013. Wildlife damage management, prevention, problem solving and conflict resolution. The Johns Hopkins Press, Baltimore. 243 pp.

Riley S. P., D. J. Hadidian, and D. A. Manski. 1998. Population density, survival, and rabies in raccoons in an urban national park. Canadian Journal of Zoology 76:1153–1164.

Ripple, W. J., and R. L. Beschta. 2006*a*. Linking a cougar decline, trophic cascade, and catastrophic regime shift in Zion National Park. Biological Conservation 133:397–408.

Ripple, W. J., and R. L. Beschta. 2006*b*. Linking wolves to willows via risk-sensitive foraging by ungulates in the northern Yellowstone ecosystem. Forest Ecology and Management 230:96–106.

Ripple, W. J., A. J. Wirsing, C. C. Wilmers, and M. Letnic. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation 160:70-79.

Ripple, W. J., L. E. Painter, R. L. Beschta, and C. C. Gates. 2010. Wolves, elk, bison, and secondary trophic cascades in Yellowstone National Park. The Open Ecology Journal 3:31-37.

Ritchie, E. G., and C. N. Johnson. 2009. Predator interactions, mesopredator release and biodiversity conservation. Ecology Letters. 12:982-998.

Roberts, N. M., and S. M. Crimmins. 2010. Bobcat population status and management in North America: Evidence of large-scale population increase. Journal of Fish and Wildlife Management 1:169-174.

Robinson, M. 1996. The potential for significant financial loss resulting from bird strikes in or around an airport. Proceedings of the Bird Strike Committee (Europe) 23:353-367.

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

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

Rogers, L. L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Transactions of the North American Wildlife and Natural Resources Conference 41:432-438.

Rosatte, R. C. 1987. Skunks. Pp 599-613 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Rosatte, R., and S. Lariviere. 2003. Skunks. Pp 692-707 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland

Roseberry, J. L., and A. Woolf. 1998. Habitat-population density relationships for white-tailed deer in Illinois. Wildlife Society Bulletin 26:252-258.

Ross, C. B., and J. Baron-Sorensen. 1998. Pet loss and human emotion: guiding clients through grief. Accelerated Development, Incorporation, Philadelphia, Pennsylvania. 166 pp.

Ruell, E. W., S. P. D. Riley, M. R. Douglas, J. P. Pollinger, and K. R. Crooks. 2009. Estimating bobcat population sizes and densities in a fragmented urban landscape using noninvasive capture-recapture sampling. Journal of Mammalogy 90:129–135.

Saliki, J. T., S. J. Rodgers, and G. Eskew. 1998. Serosurvey of selected viral and bacterial diseases in wild swine in Oklahoma. J. Wildl. Dis. 34:834-838.

Samuel, M. D., and M. R. Fuller. 1996. Wildlife radiotelemetry. Pages 370–418. *In* T. A. Bookout, ed. Research and management techniques for wildlife and habitats. Fifth edition, rev. The Wildl. Soc., Bethesda, Maryland.

Sanderson, G. C. 1987. Raccoons. Pp. 486-499 *in* M. Novak, J. A. Baker, M.E. Obbard, B. Mallock, eds., Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Schmidt, R. 1989. Wildlife management and animal welfare. Trans. N.Amer. Wildl. And Nat. Res. Conf. 54:468-475.

Schmidt, R. H., and M.W. Brunson. 1995. Assessing Public Attitudes toward Animal Damage Control Management Policies: Initial Findings. Utah State University. Logan, Utah.

Schobert, E. 1987. Telazol use in wild and exotic animals. Veterinary Medicine 82:1080–1088.

Schutz, K. E., Gren, E. A., Amundin, M., Roke, B., Palme, R. and T. Morner. 2006. Behavioral and physiological responses of trap-induced stress in European Badgers. Journal of Wildlife Management 70:884–891.

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

Seidensticker, J., M. A. O'Connell, and A. J. T. Johnsingh. 1987. Virginia opossum. Pp 247-261 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Seidler, R. G., and E. M. Gese. 2012. Territory fidelity, space use, and survival rates of wild coyotes following surgical sterilization. Journal of Ethology 1-10.

Seidler, R. G., E. M. Gese, and M. M. Conner. 2014. Using sterilization to change predation rates of wild coyotes: A test case involving pronghorn fawns. Applied Animal Behaviour Science 154:83-92.

Seward, N. W., K. C. VerCauteren, G. W. Witmer, and R. M. Engeman. 2004. Feral swine impacts on agriculture and the environment. Sheep and Goat Research Journal 19:34-40.

Sharp, T., and G. Saunders. 2008. A model for assessing the relative humaneness of pest animal control methods. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Sharp, T., and G. Saunders. 2011. A model for assessing the relative humaneness of pest animal control methods. Second Edition. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Shirley, M. G., R. G. Linscombe, N. W. Kinler, R. M. Knaus, and V. L. Wright. 1988. Population estimates of river otters in a Louisiana coastal marshland. Journal of Wildlife Management. 52: 512-515.

Shivik, J. A. 2006. Tools for the edge: What's new for conserving carnivores. BioScience 56:253-259.

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

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

Shivik, J. A., D. J. Martin, M. J. Pipas, J. Turnan, and T. J. DeLiberto. 2005. Initial Comparison: Jaws, Cables, and Cage-Traps to Capture Coyotes. Wildlife Society Bulletin 33:1373-1385.

Short, J., Turner, B., and D. Risbey. 2002. Control of feral cats for nature conservation III. trapping. Wildlife Research 29:475-487.

Short, M. J., A. W. Weldon, S. M. Richardson, and J. C. Reynolds. 2012. Selectivity and injury risk in an improved neck snare for live-capture of foxes. Wildlife Society Bulletin 36:208-219.

Simek, S. L., J. L. Belant, B. W. Young, C. Shropshire, and B. D. Leopold. 2012. History and status of the American black bear in Mississippi. Ursus 23:159-167.

Singer, F. J., W. T. Swank, and E. E. C. Clebsch. 1982. Some ecosystem responses to European wild boar rooting in a deciduous forest. Research Resources Management Report No. 54. USDI, National Park Service, Atlanta, Georgia.

Slate, D. 1980. A study of New Jersey raccoon populations— determination of the densities, dynamics and incidence of disease in raccoon populations in New Jersey. N.J. Div. Fish, Game, and Wildl., Pittman-Robertson Proj. W-52-R-8, Final Rep. 67 pp.

Slate, D.A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. In Trans. N. A. Wildl. Nat. Res. Conf 57:51-62.

Slater, M. R. 2004. Understanding issues and solutions for unowned, free-roaming cat populations. Journal of the American Veterinary Medical Association 225:1350-1354.

Smith, R. K., A. S. Pullin, G. B. Stewart, and W. J. Sutherland. 2011. Is nest predator exclusion an effective strategy for enhancing bird populations? Biological Conservation 144:1–10.

South Carolina Wild Hog Task Force. 2012. South Carolina's growing wild hog problem: Recommendations for management and control.

https://www.clemson.edu/extension/wildlife/wildhogs/documents/wild_hog_white_paper.pdf. Accessed November 18, 2024.

Speich, S. 1986. Colonial waterbirds. Pp. 387-405 *in* A. Y. Cooperrider, R. J. Boyd, and H. R. Stuart, eds. Inventory and monitoring of wildlife habitat. USDI, Bureau of Land Management Service Center, Denver, Colorado.

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

Stenseth, N. C., W. Falck, O. N. Bjornstad, and C. J. Kreb. 1997. Population regulation in snowshoe hare and Canadian lynx: Asymmetric food web configurations between hare and lynx. Proceedings of the National Academy of Sciences 94:5147-5152.

Stevens, R. L. 2010. The feral hog in Oklahoma. Second Edition. Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

Stewart, C. M., and N. B. Veverka. 2011. The extent of lead fragmentation observed in deer culled by sharpshooting. Journal of Wildlife Management 75:1462-1466.

Stoddart, L. C. 1984. Relationships between prey base fluctuations and coyote depredation on sheep on the Idaho National Engineering Laboratory (INEL), 1979-1982. Unpublished Research Work Unit Report. Denver Wildl. Res. Cent. 16 pp.

Stoddart, L. C., R. E. Griffiths, and F. F. Knowlton. 2001. Coyote responses to changing jackrabbit abundance affect sheep predation. Journal of Range Management 54:15-20.

Stoskopf, M. K., and F. B. Nutter. 2004. Analyzing approaches to feral cat management – one size does not fit all. Journal of the American Veterinary Medical Association 225:1361-1364.

Stoudt, J. H. 1982. Habitat use and productivity of canvasbacks in southwestern Manitoba, 1961-72. Pec. Sci. Rept. Wildl. 248. U.S. Fish and Wildlife Service. Washington, D.C. 31 pp.

Swihart, R. K., and P. M. Picone. 1995. Use of woodchuck burrows by small mammals in agricultural habitats. American Midland Naturalist 133:360-363.

TVA. 2011. Final Environmental Impact Statement: Natural Resources Plan-Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. Tennessee Valley Authority, Knoxville, Tennessee. 321 pp + appendices.

TVA. 2020*a*. Tennessee Valley Authority: Natural resources plan. Tennessee Valley Authority, Knoxville, Tennessee. 46 pp.

TVA. 2020*b*. Update to TVA's Natural Resource Plan Final Supplemental Environmental Impact Statement. Tennessee Valley Authority, Knoxville, Tennessee. 328 pp.

Terrel, T. L. 1972. The swamp rabbit (*Sylvilagus aquaticus*) in Indiana. American Midland Naturalist 87:283-295.

The Wildlife Society. 2017. Final position statement: Wildlife damage management. The Wildlife Society, Washington., D.C. 2 pp.

The Wildlife Society. 2022. Final position statement: Lead in hunting ammunition and fishing tackle. The Wildlife Society, Washington, D.C. 2 pp.

Thorpe, J. 1996. Fatalities and destroyed civil aircraft due to bird strikes, 1912-1995. Proceedings of Bird Strike Committee Europe 23:17-32.

Thorpe, J. 1997. The implications of recent serious bird strike accidents and multiple engine ingestions. Bird Strike Committee USA, Boston, Massachusetts.

Till, J. A. 1992. Behavioral effects of removal of coyote pups from dens. Proc. Vertebr. Pest Conf. 15:396-399.

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

Timmons, J. B., B. Higginbotham, R. Lopez, J. C. Cathey, J. Mellish, J. Griffin, A. Sumrall, and K. Skow. 2012. Feral hog population growth, density and harvest in Texas. Texas A&M AgriLife Extension Service Report. Texas A&M University: College Station, TX.

Tranel, M. A., and R. O. Kimmel. 2009. Impacts of lead ammunition on wildlife, the environment, and human health—A literature review and implications for Minnesota. In R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt, eds. Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI: 10.4080/ilsa.2009.0307.

Trapp, G. R. 1978. Comparative behavioral ecology of the ringtail (*Bassariscus astutu*s) and gray fox (*Urocyon cinereoargenteu*s) in southwestern Utah. Carnivore 1:3–32.

Treves, A., and L. Naughton-Treves. 2005. Evaluating lethal control in the management of human-wildlife conflict. Pp. 86-106 in R. Woodroffe, S. Thirgood, A. Rabinowitz, eds. People and Wildlife: Conflict or Coexistence. University of Cambridge Press, United Kingdom.

Turner, J. W., J. F. Kirkpatrick, and I. K. M. Liu. 1993. Immunocontraception in white-tailed deer. Pp 147-159 *in* T.J. Kreeger, Technical Coordinator. Contraception in Wildlife Management. USDA/APHIS, Technical Bulletin No. 1853.

Turkowski, F.J., A.R. Armistead, and S.B. Linhart. 1984. Selectivity and effectiveness of pan tension devices for coyote foothold traps. Journal of Wildlife Management 48:700-708.

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

Twichell, A. R., and H. H. Dill. 1949. One hundred raccoons from one hundred and two acres. Journal of Mammalogy 30:130–133.

United States Census Bureau. 2023. Quick facts: Mississippi. United States Census Bureau website: https://www.census.gov/quickfacts/MS. Accessed November 18, 2024.

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

USDA. 2009. Info sheet: PRRS seroprevalence on U.S. swine operations. United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, Centers for Epidemiology and Animal Health, Fort Collins, Colorado. 2 pp.

USDA. 2010*b*. Questions and Answers: GonaCon™-Birth control for deer. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 3 pp.

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

USDA. 2019*a*. Wildlife Services Strategic Plan: FY 2020-2024. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 30 pages.

USDA. 2019*b*. Immobilization and euthanasia manual. United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 100 pp.

USDA. 2019*c*. Chapter V: The use of aircraft in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/5-aircraft-use-peer-reveiwed.pdf. Accessed December 3, 2024.

USDA. 2019*d*. Chapter II: The use of cage traps in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/2-cage-trap-peer-reviewed.pdf. Accessed December 3, 2024.

USDA. 2019*e*. Chapter III: The use of cable devices in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management

Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/3-cable-devices-peer-reviewed.pdf. Accessed December 3, 2024.

USDA. 2019*f*. Chapter IV: The use of foothold traps in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/4-foothold-trap-peer-reviewed.pdf. Accessed December 3, 2024.

USDA. 2019*g*. Chapter VI: The use of firearms in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/6-firearms-use-peer-reviewed.pdf. Accessed December 3, 2024.

USDA. 2019*h*. Chapter VIII: The use of carbon monoxide in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/8-gas-cartridge-peer-reviewed.pdf. Accessed December 3, 2024.

USDA. 2020. Chapter XIII: The use of nets in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/13-nets.pdf. Accessed December 3, 2024.

USDA. 2021. Chapter XV: The use of dogs and other animals in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/15-dog-use.pdf. Accessed December 3, 2024.

USDA. 2022*a*. Chapter XII: The use of lead in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/12-lead.pdf. Accessed December 3, 2024.

USDA. 2022*b*. Chapter XI: The use of GonaCon in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/11-gonacon.pdf. Accessed December 3, 2024.

USDA. 2022*c*. Chapter XIV: The use of quick-kill traps in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/14-quick-kill-traps.pdf. Accessed December 3, 2024.

USDA. 2022*d*. Chapter XXII: The use of exclusion in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/22-exclusion.pdf. Accessed December 3, 2024.

USDA. 2023*a*. Chapter XVIII: The use of hand capture and biological sampling in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/18-hand-capture.pdf. Accessed December 3, 2024.

USDA. 2023*b*. Chapter XXI: The use of explosive materials in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/21-explosives.pdf. Accessed December 3, 2024.

USDA. 2023*c*. Chapter XXIV: Carcass disposal in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/23-carcass-disposal.pdf. Accessed December 3, 2024.

USDA. 2024*a*. Chapter XXIII: Use of registered chemical repellents in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/24-registered-chemical-repllents.pdf. Accessed December 3, 2024.

USDA. 2024*b*. Chapter XXVII: Use of immobilization and euthanasia drugs in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services.

https://www.aphis.usda.gov/sites/default/files/27-euthanasia-immobilization.pdf. Accessed December 3, 2024.

USDA. 2024*c*. Chapter XXIX: Use of minimum risk pesticides in wildlife damage management. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. https://www.aphis.usda.gov/sites/default/files/29-minimum-risk-pesticides.pdf. Accessed December 3, 2024.

United States Department of Justice. 2014. Two sentenced for violating Eagle Protection Act. United States Department of Justice, United States Attorney's Office, Western District of Wisconsin.

United States Department of Justice. 2015. Farmer sentenced for poisoning bald eagles. United States Department of Justice, United States Attorney's Office, Western District of New York.

United States Drug Enforcement Administration. 2019. Nalbuphine hydrochloride. Drug Enforcement Administration, Diversion Control Division, Drug and Chemical Evaluation Section. https://www.deadiversion.usdoj.gov/drug_chem_info/nalbuphine.pdf. Accessed November 18, 2024.

USFWS. 2007. National bald eagle management guidelines. Unites States Fish and Wildlife Service. 25 pp.

USFWS. 2019. Species status assessment report for the eastern black rail (*Laterallus jamaicensis jamaicensis*), Version 1.3. United States Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. 194 pp.

USFWS. 2024. Louisiana quillwort (*Isoetes louisianensis*) 5-year status review: Summary and evaluation. United States Fish and Wildlife Service, Southeast Region, Mississippi Ecological Services Field Office, Jackson, Mississippi. 12 pp.

USFWS. 2021. Species status assessment report for the gopher tortoise (*Gopherus plyphemus*), Version 0.4. United States Fish and Wildlife Service, Southeast Region, Atlanta, Georgia. 288 pp.

USFWS. 2024. Waterfowl population status, 2024. U.S. Department of the Interior, Washington, D.C. USA.

USFWS and the United States Department of Commerce. 2011. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. 172 pp.

United States Forest Service. 1992. Overview, Report to Congress, Potential Impacts of Aircraft Overflights of National Forest System Wilderness. Report to Congress. Prepared pursuant to Section 5, Public Law 100-91, National Park Overflights Act of 1987.

VanDruff, L. W. 1971. The ecology of the raccoon and opossum, with emphasis on their role as waterfowl nest predators. Ph.D. Thesis. Cornell University, Ithaca, New York. 140 pp.

VerCauteren, K. C., M. J. Lavelle, T. M. Gehring, and J. Landry. 2012. Cow dogs: Use of livestock protection dogs for reducing predation and transmission of pathogens from wildlife to cattle. Applied Animal Behaviour Science 140:128-136.

VerCauteren, K., N. Seward, D. Hirchert, M. Jones, and S. Beckerman. 2005. Dogs for reducing wildlife damage to organic crops: a case study. Proceedings of the Wildlife Damage Management Conference 11:286–293.

Verts, B. J. 1963. Movements and populations of opossums in a cultivated area. Journal of Wildlife Management 27:127129.

Vincelette, H., R. Buxton, N. Kleist, M. F. McKenna, D. Betchkal, and G. Wittemyer. 2021. Insights on the effect of aircraft traffic on avian vocal activity. Ibis 163:353-365.

Virchow, D., and D. Hogeland. 1994. Bobcats. Pp C35-C45 *in* S.E. Hygnstrom, R.M. Timm and G.E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

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

Voigt, D. R., and W. E. Berg. 1987. Coyote. Pp 345-357 *in* M. Novak, J. A. Baker, M. E. Obbard, B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Voigt, D. R, and B. D. Earle. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management 47:852–857.

Wagner, F. H. 1988. Predator control and the sheep industry. Regina Books, Claremont, California, USA.

Wagner, F. H., and L. C. Stoddart. 1972. Influence of coyote predation on black-tailed jackrabbit populations in Utah. Journal of Wildlife Management 36:329–342.

Wagner, K. K. 1997. Preventive predation management: an evaluation using winter aerial coyote hunting in Utah and Idaho. Ph.D. Thesis. Utah St. University, Logan, Utah.

Wagner, K. K. and M. R. Conover. 1999. Effect of preventive coyote hunting on sheep losses to coyote predation. Journal of Wildlife Management 63:606-612.

Wallach, A. D., C. N. Johnson, E. G. Ritchie, and A. J. O'Neill. 2010. Predator control promotes invasive dominated ecological states. Ecology Letters 13:1008–1018.

Wang, Z., A. S. Griffin, A. Lucas, and K. C. Wong. 2019. Psychological warfare in vineyard: Using drones and bird psychology to control bird damage to wine grapes. Crop Protection 120:163-170.

Waser, N. M., M. V. Price, D. T. Blumstein, S. R. Arozqueta, B. D. C. Escobar, R. Pickens, and A. Pistoia. 2014. Coyotes, deer, and wildflowers: Diverse evidence points to a trophic cascade. Naturwissenschaften 101:427–436.

Watts, A. C., J. H. Perry, S. E. Smith, M. A. Burgess, B. E. Wilkinson, Z. Szantoi, P. G. Ifju, and H. F. Percival. 2010. Small unmanned aircraft systems for low-altitude aerial surveys. Journal of Wildlife Management 74:1614-1619.

Way, J. G., Ortega, I. M., Auger, P. J., and E. G. Strauss. 2002. Box-trapping eastern coyotes in southeastern Massachusetts. Wildlife Society Bulletin 30:695-702.

Weisenberger, M. E., P. R. Krausman, M. C. Wallace, D. W. De Young, and O. E. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. Journal of Wildlife Management 60:52-61.

Weisman, A. D. 1991. Bereavement and companion animals. Omega: Journal of Death and Dying 22: 241-248.

West, B. C., A. L. Cooper, and J. B. Armstrong. 2009. Managing wild pigs: A technical guide. Human-Wildlife Interactions Monograph 1:1-55.

Westman, W. E. 1978. Measuring the inertia and resilience of ecosystems. BioScience 28:705–710.

White, C. M., and S. K. Sherrod. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor surveys. Raptor Res. 7:97-104.

White, C. M., and T. L. Thurow. 1985. Reproduction of Ferruginous Hawks exposed to controlled disturbance. Condor 87:14-22.

White, P. J., T. J. Kreeger, U. S. Seal, and J. R. Tester. 1991. Pathological Responses of Red Foxes to Capture in Box Traps. Journal of Wildlife Management 55:75-80.

Will, D., C. C. Hanson, K. J. Campbell, D. K. Garcelon, and B. S. Keitt. 2010. A trap monitoring system to enhance efficiency of feral cat eradication and minimize adverse effects on non-target endemic species on San Nicolas Island. Pp. 79-85 in R. M. Timm and K. A. Fagerstone, eds., Proc. 24th Vertebr. Pest Conf.

Williams, C. L., K. Blejwas, J. J. Johnston, and M. M. Jaeger. 2003. Temporal genetic variation in a coyote (*Canis latrans*) population experiencing high turnover. Journal of Mammalogy 84:177-184.

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

Winter. 2004. Trap-neuter-release programs: The reality and the impacts. Journal of the American Veterinary Medical Association 225:1369-1376.

Wiseman G. L., and G. O. Hendrickson. 1950. Notes on the life history of the opossum in southeast Iowa. Journal of Mammalogy 31:331-337.

Witmer, G. W., J. L. Bucknall, T. H. Fritts, and D. G. Moreno. 1996. Predator management to protect endangered avian species. Trans. 61st No. Amer. Wildl. And Natur. Resourc. Conf. 61:102-108.

Witmer, G. W., R. B. Sanders, and A. C. Taft. 2003. Feral swine-Are they a disease threat to livestock in the United States? Pp 316-325 *in* K. A. Fagerstone, and G. W. Witmer eds. Proceedings of the 10th Wildlife Damage Management Conference. (April 6-9, 2003, Hot Springs, Arkansas). The Wildlife Damage Management Working Group of The Wildlife Society, Fort Collins, Colorado.

Wolfe, L. L., C. T. Goshorn, and S. Baruch-Mordo. 2008. Immobilization of black bears (*Ursus americanus*) with a combination of butorphanol, azaperone, and medetomidine. Journal of Wildlife Disease. 44(3): 748–752.

Wood, G. W., and R. H. Barrett. 1979. Status of the wild pig in the United States. Wildlife Society Bulletin 35:237-246.

Wyckoff, A. C., S. E. Henke, T. A. Campbell, D. G. Hewitt, and K. C. VerCaurteren. 2009. Feral Swine Contact with Domestic Swine: A Serologic Survey and Assessment of Potential for Disease Transmission. Journal of Wildlife Diseases 45:422-429.

Yeager, L. E., and R. G. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois river bottom lands. Journal of Wildlife Management7:45–60.

Young, B. W. 2006. Conservation and management of black bears in Mississippi. Mississippi Museum of Natural Science, Mississippi Department of Wildlife, Fisheries, and Parks, Jackson, Mississippi. 59 pp.

Young, B. W. 2011. Bumper crop of baby bears. Mississippi Outdoors. Mississippi Department of Wildlife, Fisheries, and Parks, Jackson, Mississippi.

Young, J. K., E. Miller, and A. Essex. 2015. Evaluating fladry designs to improve utility as a nonlethal management tool to reduce livestock predation. Wildlife Society Bulletin 39:429-433.

Young, J. K., J. Draper, and S. Breck. 2019. Mind the Gap: Experimental tests to improve efficacy of fladry for nonlethal management of coyotes. Wildlife Society Bulletin 43:265-271.

Young, J. K., J. T. Schultz, B. Jolley, Nekol Basili, and J. Draper. 2022. Social learning of avoidance behaviors: Trap aversion in captive coyotes. Animal Behavior and Cognition 9:336-348.

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

APPENDIX B. LAWS AND REGULATIONS

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

National Environmental Policy Act

All federal actions are subject to the National Environmental Policy Act (NEPA) (Public Law 91-190, 42 USC 4321 et seq.). WS follows USDA (7 CFR 1b et seq.) and APHIS implementing guidelines (7 CFR 372 et seq.) as part of the decision-making process. Those laws, regulations, and guidelines generally outline five broad types of activities that federal agencies must accomplish as part of any project: public involvement, analysis, documentation, implementation, and monitoring. The NEPA also sets forth the requirement that all major federal actions be evaluated in terms of their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts. This EA documents the analyses resulting from proposed federal actions, informs decision-makers and the public of reasonable alternative approaches capable of avoiding or minimizing adverse impacts, and serves as a decision-aiding mechanism to ensure that WS infuses the policies and goals of the NEPA into agency actions. WS and the TVA prepared this EA by integrating as many of the natural and social sciences as warranted, based on the potential effects of the alternative approaches, including the potential effects of the alternative approaches.

Endangered Species Act

Under the Endangered Species Act, all federal agencies will seek to conserve threatened and endangered species and will utilize their authorities in furtherance of the purposes of the Act (16 USC 1531(c)). Evaluation of the alternative approaches in regard to the Endangered Species Act will occur in Section 3.1.2 of this EA and Section II of Appendix D.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act and its implementing regulations (7 USC 136 et seq.) require the registration, classification, and regulation of all pesticides used in the United States. The EPA is responsible for implementing and enforcing the Federal Insecticide, Fungicide, and Rodenticide Act. The EPA and the Mississippi Department of Agriculture and Commerce regulate pesticides that could be available to manage damage associated with mammals in the state.

National Historic Preservation Act of 1966, as amended

The National Historic Preservation Act (Public Law 89-665) and its implementing regulations (see 36 CFR 800) require federal agencies to initiate the Section 106 process if an agency determines that the agency's actions are undertakings as defined in 36 CFR 800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects on historic properties. If the undertaking is a type of activity that does not have the potential to cause effects on historic properties, assuming such historic properties were present, the agency official has no further obligations under Section 106.

None of the methods described in the EA that would be available cause major ground disturbance; any physical destruction or damage to property; any alterations of property, wildlife habitat, or landscapes; and would not involve the sale, lease, or transfer of ownership of any property. In general, available methods do not have the potential to introduce visual, atmospheric, or audible elements to areas that could result in effects on the character or use of historic properties. Therefore, the methods that would be available under the alternative approaches would not generally be the types of methods that would have the potential to affect historic properties. If WS and/or the TVA planned an individual activity with the potential to affect historic resources under an alternative approach selected because of a decision on this EA, WS and/or the TVA would conduct the site-specific consultation, as required by Section 106 of the National Historic Preservation Act, as necessary.

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

The Native American Graves Protection and Repatriation Act of 1990

The Native American Graves Protection and Repatriation Act (Public Law 101-106, 25 USC 3001 et seq.) requires federal agencies to notify the Secretary of the Department that manages the federal lands upon the discovery of Native American cultural items on federal or tribal lands. Federal agencies are to discontinue work until the agency has made a reasonable effort to protect the items and notify the proper authority.

Federal Food, Drug, and Cosmetic Act

The Federal Food, Drug, and Cosmetic Act (21 USC 301 et seq.) places administration of pharmaceutical drugs, including those immobilizing drugs used for wildlife capture and handling, under the Food and Drug Administration.

Controlled Substances Act of 1970

The Controlled Substances Act (21 USC 821 et seq.) requires an individual or agency to have a special registration number from the United States Drug Enforcement Administration to possess controlled substances, including controlled substances used for wildlife capture and handling.

Animal Medicinal Drug Use Clarification Act of 1994

The Animal Medicinal Drug Use Clarification Act and its implementing regulations (21 CFR 530) establish several requirements for the use of animal drugs, including those animal drugs used to capture and handle wildlife in damage management programs. Those requirements are: (1) a valid "*veterinarian-client-patient*" relationship, (2) well defined record keeping, (3) a withdrawal period for animals that have been administered drugs, and (4) identification of animals. A veterinarian, either on staff or on an advisory basis, would be involved in the oversight of the use of animal capture and handling drugs under any alternative where WS could use those immobilizing drugs and euthanasia chemicals. Veterinary authorities in each state have the discretion under this law to establish withdrawal times (*i.e.*, a period after a drug is administered that must lapse before an animal may be used for food) for specific drugs. Animals that people might consume within the withdrawal period must be identifiable (*e.g.*, use of ear tags) and labeled with appropriate warnings.

Airborne Hunting Act

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

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

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

Invasive Species - Executive Order 13112 and Executive Order 13751

Executive Order 13112 establishes guidance for federal agencies to use their programs and authorities to prevent the spread or to control populations of invasive species that cause economic or environmental harm or harm to human health. The Order states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law: 1) reduce invasion of exotic species and the associated damages, 2) monitor invasive species populations and provide for restoration of native species and habitats, 3) conduct research on invasive species and develop technologies to prevent introduction, and 4) provide for environmentally sound control and promote public education of invasive species. Executive Order 13751 amended Executive Order 13112 by clarifying the operations of the National Invasive Species Council and by expanding its membership. In addition, Executive Order 13751 incorporated additional considerations into federal efforts to address invasive species and to strengthen coordinated, cost efficient federal actions.

Consultation and Coordination with Indian Tribal Governments – Executive Order 13175

Executive Order 13175 directs federal agencies to provide federally recognized tribes the opportunity for government-to-government consultation and coordination in policy development and program activities that may have direct and substantial effects on their tribe. Its purpose is to ensure that tribal perspectives on the social, cultural, economic, and ecological aspects of agriculture, as well as tribal food and natural resource priorities and goals, are heard and fully considered in the decision-making processes of all parts of the federal government.

Coastal Zone Management Act of 1972, as amended (16 USC 1451-1464, Chapter 33; PL 92-583, October 27, 1972; 86 Stat. 1280).

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

Wildlife Definitions and Interpretations (Mississippi Code Annotated §49-7-1, as amended)

Section 49-7-1 of the Mississippi Code of 1972 defines those mammal species that are considered game species, fur-bearing species, and nuisance animals. Of those species addressed in this EA, game species include white-tailed deer, rabbits, and squirrels while fur-bearing species include opossums, otters, raccoons, and bobcats. Wildlife defined as nuisance animals include fox, skunks, feral swine, and coyotes (Public Notice LE4-3779). People may remove nuisance animals at any time subject to certain provisions.

APPENDIX C. DESCRIPTION OF METHODOLOGIES AVAILABLE TO MANAGE DAMAGE CAUSED BY MAMMALS IN MISSISSIPPI

A variety of methods would potentially be available for WS to use in Mississippi to manage damage caused by mammals. Various federal, state, and local statutes and regulations and WS directives would govern WS' use of damage management methods. When WS provides assistance, WS' personnel would use the WS Decision Model (see WS Directive 2.201) to identify methods (see WS Directive 2.101) appropriate to reducing damage or the threat of damage. In general, when providing assistance, WS' personnel would consider an adaptive approach that would integrate a combination of methods to resolve damage and reduce threats of damage (see WS Directive 2.105). WS could recommend or use the following non-lethal and lethal methods in Mississippi.

I. NON-LETHAL METHODS

Non-lethal methods consist primarily of tools or devices used to disperse, exclude, or capture a particular animal or a group of animals to alleviate damage and conflicts, but could include a reproductive inhibitor. When evaluating management methods and formulating a management strategy, WS' personnel would give preference to non-lethal methods when they determine those methods to be practical and effective (see WS Directive 2.101). Most of the non-lethal methods available to WS would also be available to other entities and other entities could employ those methods to alleviate damage caused by mammal species in Mississippi.

Human presence

Human presence may consist of physical actions of people, such as clapping, waving, or shouting, or the presence of people and/or a vehicle at a location where damage or threats of damage are occurring. For example, animals may associate a vehicle with previous hazing activities and approaching an area in that vehicle or a similar vehicle may disperse target species from an area. Similarly, making a person's presence known to target species by clapping, waving, or shouting can often disperse animals from an area. When animals begin to associate people with hazing and/or shooting activities, the presence of people can disperse those target species when they see people approach. Human activities can also enhance the effectiveness of effigies, such as human effigies, because they associate people with hazing or shooting activities. Human presence could also include WS' activities while conducting activities, such as foot traffic around project sites or the use of vehicles to access locations.

Modifying Cultural Practices

When providing technical assistance, WS could recommend that people requesting assistance modify behaviors that may be contributing to damage or threats of damage. However, in those cases, the entity experiencing damage, or the threat of damage, would be responsible for implementing the recommendations made by WS' personnel. Recommendations could include modifying the behavior of people that may be attracting or contributing to the damage caused by mammals. For example, artificial feeding of animals by people can attract and sustain more animals in an area than natural food supplies could normally support. Similarly, WS could recommend people feed pets indoors or remove pet food from outside that may be attracting animals. WS could recommend securing garbage cans to prevent animals from accessing them. Altering how bird feeders are hung and constructing mounting poles for the feeders that cannot be climbed by tree squirrels can reduce the presence of localized populations along with their associated damage.

Pasturing goats, sheep, and/or cattle together when those animals have formed bonds so that they stay together may reduce predation (Anderson et al. 1987, Hulet et al. 1987, 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 are much lower than that of sheep and goats. The presence of cattle may be adequate to act as a predation deterrent.

Limited Habitat Modification

In most cases, the resource or property owner would be responsible for implementing habitat modifications, and WS would only provide recommendations on the type of modifications that would provide the best chance of achieving the desired effect. People can manage habitat to make it less attractive to certain wildlife species. For example, WS' personnel could recommend limited habitat management in urban and suburban areas, such as at golf courses, residential homes, and business, where requesters can plant vegetation that is less palatable to a species. Limitations of habitat management as a method of reducing animal damage are determined by the characteristics of the species involved, the nature of the damage, economic feasibility, and other factors.

Supplemental Feeding and Lure Crops

Supplemental feeding and lure crops are food resources planted or provided to attract wildlife away from more valuable resources (*e.g.*, crops). The intent is to provide a more attractive food source so that the animals causing damage would consume it rather than a more valuable resource. In feeding programs, an alternative food source with a higher appeal is offered to target animals with the intention of luring them from feeding on affected resources. This method can be ineffective if other food sources are available. For lure crops to be effective, the ability to keep animals from surrounding fields would be necessary, and the number of alternative feeding sites must be minimal (Fairaizl and Pfeifer 1988). Additionally, lure crops reduce damage for only a short time (Fairaizl and Pfeifer 1988) and damage by animals is often continuous. The resource owner would be limited in implementing this method contingent upon ownership of or ability to manage the property.

Conventional Fencing

Fencing of small critical areas can sometimes prevent mammal species that cannot climb from entering areas of protected resources. With any type of fencing the height of the fence must be tall enough so animals cannot go over the top. The distance between the fence and the ground or the distance between wires must be small enough to exclude animals. Many mammals can 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 that leave minimal gaps when closed or that 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 installed with an underground skirt can prevent access to areas for many mammal species that dig, such as coyotes and feral dogs. Areas, such as airports, yards, or gardens, may be fenced to exclude mammal species. Fencing requires maintenance because animals are quick to exploit gaps.

Fencing could include the use and recommendation of electrified fencing. Electric fences of various constructions have been used effectively to reduce damage to various crops by deer, raccoons, and other species (Boggess 1994, Craven and Hygnstrom 1994). Electric fences can be built for temporary or permanent use. Temporary electric fences can be constructed of polywire, poly tape, or similar materials. 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 can be effective at excluding mammal species. However, animals that are willing to expose themselves to electric shock can avoid electric wires while passing through, digging under, jumping over fences, or exploiting times when the fence is not charged. In addition, some species, including red fox, 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. The application of electrified fencing would be limited to rural settings due to the possibility/likelihood of interaction with people and pets in populated areas. Exclusion adequate to stop animal movements can also restrict movements of livestock, people, and other wildlife (Fuller-Perrine and Tobin 1993).

Additional exclusion methods

Hardware cloth or other metal barriers can sometimes be used to prevent the entry of smaller mammals into buildings through existing holes or gaps. Exclusion and one-way devices such as netting or nylon window screening can be used to exclude bats from a building or an enclosed structure (Greenhall and Frantz 1994). Using hardware cloth or other metal barriers can sometimes prevent girdling and gnawing of valuable trees by wildlife, such as eastern cottontails. In many cases, WS could recommend the use of exclusion methods, but the implementation of specific methods would be the responsibility of the property owner or manager. If requested, WS could use predator exclosures around nests to reduce predation risks to ground nesting bird species.

If requested, WS could use predator exclosures around nests to reduce predation risks to ground nesting bird species. 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, Isaksson et al. 2007). Therefore, the use of exclosures should be carefully evaluated prior to use (Smith et al. 2011).

Visual Scaring Techniques

Visual scaring techniques that WS may use and/or recommend to deter or scare target animals from an area could include electronic guards (siren strobe-light devices), lights, scarecrows, human effigies, effigies of predators, Mylar tape, eyespot balloons, flags, and fladry. Visual scaring techniques can act as novel stimuli that mammals act to avoid. The intent associated with the use of visual dispersal methods is to elicit a flight response by scaring target animals from an area where damage is occurring or where damage could occur. WS' personnel would place those methods in areas to scare and disperse target mammal species. The success of frightening methods depends on an animal's fear of, and subsequent aversion to, offensive stimuli (Shivik and Martin 2001, Shivik et al. 2003, Mettler and Shivik 2007). A persistent effort is usually required to effectively apply frightening techniques and the techniques must be sufficiently varied to prolong their effectiveness. Over time, animals often habituate to commonly used scare tactics and ignore them (*e.g.*, see Dolbeer et al. 1986, Bomford 1990, Belant et al. 1996, Shivik et al. 2003, Mitchell et al. 2004, Shivik 2006). Animals quickly learn to ignore visual and other scaring devices if the animals' fear of the methods is not reinforced with shooting or other tactics. Visual scaring techniques can be impractical in many locations and has met with some concerns due to the negative esthetic appearance presented on the properties where those methods are used.

Mylar tape has a highly reflective surface that produces flashes of light as sunlight reflects off the surface, which can startle animals. In addition, the metallic rattle and quick movement of Mylar tape as it moves in the wind can startle animals. WS' personnel could attach Mylar tape to a stake and then insert the stake into the ground so the Mylar tape was visible and could move in the wind. In addition, WS' personnel could tie Mylar tape to structures in a similar manner to using a stake. Flagging and fladry often works similar to Mylar tape, which often creates quick movements when they blow in the wind. WS could use and/or recommend the use of fladry to address livestock predation (Mettler and Shivik 2007, Davidson-Nelson and Gehring 2010, Young et al. 2015, Young et al. 2019).

Scarecrows and effigies are models or silhouettes that often depict predatory animals (*e.g.*, alligators, owls) or people (*e.g.*, scarecrows) that applicators can place in areas where animals cause damage or pose a threat of damage. Scarecrows and effigies may elicit a flight response from target animals, which disperses those animals from the area. Effigies and scarecrows that pop-up into the air and/or have moving parts are often more effective at dispersing animals. Scarecrows and effigies would be most effective when they were moved frequently, alternated with other methods, and were well maintained. However, scarecrows and effigies tend to lose effectiveness over time and become less effective as populations increase.

WS' personnel could use lasers and lights to disperse animals when low-light conditions exist. Lasers and lights may be novel stimuli that animals act to avoid. Lights would primarily consist of high-powered spotlights. Lasers and lights have advantages over other dispersal methods because they are silent, and WS' personnel can use those methods directly at target animals. Therefore, WS' personnel can use those methods is areas where disturbing other wildlife is a concern.

Animals quickly learn to ignore visual scaring devices and aural deterrents if the animals' fear of the methods is not reinforced with shooting. Visual scaring techniques can be impractical in many locations and has met with some concerns due to the negative esthetic appearance presented on the properties where those methods are used.

Electronic hazing devices

WS could use and/or recommend electronic guards to disperse and prevent damage caused by mammal species. The electronic guard uses a combination of stimuli (siren and strobe light) to disperse animals, primarily predators. When operational, the device can automatically turn 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 can 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. In some situations, the level of volume required for this method to be effective may disturb local residents or be prohibited by local noise ordinances. The use of electronic hazing devices can have some drawbacks. For example, mammals hazed from one area where they were causing damage frequently move to another area where they continue to cause damage.

Paintballs, Rubber Bullets, Bean Bags, and Similar Non-lethal Methods

WS' personnel may use paintballs and recreational paintball equipment to supplement other harassment methods. Paintballs consist of a gelatin shell filled with a non-toxic glycol and water-based coloring that rapidly dissipates and is not harmful to the environment. A paintball marker (or gun) uses compressed carbon dioxide to propel paintballs an average of 280 feet per second, but they are not very accurate. The discharge of the paintball marker combined with the sound of paintballs hitting the ground or splashing in water may be effective in dispersing animals, especially when combined with other harassment techniques. Although paintballs break easily and velocity rapidly decreases with distance, firing at close range is discouraged to avoid harming animals. The use of paintballs may be restricted in some areas by local ordinances.

Rubber bullets, beanbags, and similar less than lethal projectiles are shot from a firearm, primarily a shotgun. Rubber bullets, beanbags, and similar less than lethal projectiles do not kill or pass through an animal but are intended to cause pain and discomfort, so the animal associates the pain and discomfort with a specific activity. WS could use rubber bullets, beanbags, and similar less than lethal projectiles for larger mammalian species, such as black bears. In general, bean bags are a one-inch fabric bag containing rubber or metal shot that is fired from a shotgun while rubber bullets are rubber slugs fired from a shotgun. Other less than lethal projectiles generally consist of rubber shot or a projectile similar to a beanbag. Rubber bullets, beanbags, and similar less than lethal projectiles are intended to impact large muscle masses of the target animals to prevent serious injury.

Pyrotechnics

The term "*pyrotechnic*" encompasses a number of commercially available devices that produce a loud noise after firing the device. People may refer to some of the common individual devices as "*bird bombs*", "*screamers*", "*bangers*", "*shell crackers*", or "*CAPA*". The most common pyrotechnics are pyrotechnics that people fire from a pyrotechnic launcher or from a shotgun. Those pyrotechnics fired from a launcher or from a shotgun travel approximately 200 to 300 feet downrange. Some types of pyrotechnics emit a loud whistle as they travel while some travel downrange and then explode with a bang. Pyrotechnics that whistle as they travel and those that explode with a bang after travelling downrange generally emit a 100-decibel report that can startle target animals. A long-range pyrotechnic that is commercially available can travel approximately 1,000 feet downrange and produce a 150-decibel report. Pyrotechnics are one of the primary methods that WS' personnel use to disperse animals.

Propane Cannons

These small cannons operate using propane gas and when fired, produce a noise similar to a firearm. The user attaches the cannon to a propane tank using a hose. Opening the valve on the propane tank releases propane gas into a bladder system on the propane cannon, which begins to fill with propane gas. Once the bladder system fills, it releases the propane gas into the chamber of the cannon and simultaneously, a striking mechanism produces a spark that ignites the gas causing a loud explosion similar to the sound of a firearm firing. Propane cannons use a timing mechanism that people can adjust to vary how often the cannon fires. For example, propane cannons may be set to fire every five minutes. Some models are capable of being set to produce multiple blasts. For example, the user can set the propane cannon to produce a random series of single, double, or triple blasts. In addition, attachments to propane cannons can allow the user to control when the cannon operates during a 24-hour period. For example, the user may set the cannon to begin firing in the morning and then shut off in the evening. The user can also fit cannons with mechanisms that allow the cannon to rotate so that each firing occurs from a different direction.

Trained Dogs

WS' personnel could use specially trained dogs to locate target species, such as feral swine. 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. 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. Those dogs may also scent mark (urinate or defecate), which may serve as an attractant to other canids. For tracking or trailing dogs, the dogs would receive training to follow the scent of a target species and to avoid following the scent of non-target species. WS' personnel typically find the track of the target species in areas with recent damage or at a location where recent sightings of target animals have occurred. Personnel would then put their dogs on the tracks of the target animal or guide the dogs in an area until the dogs locate the scent of a target animal. Typically, if the scent is not too old, the dogs can follow the trail. Once a target animal is located, WS' personnel can capture the target animal or lethally remove the animal. People commonly use different breeds of hounds, such as blue tick, red-bone, and Walker to track and "*bay*" feral swine. For more information on WS' use of trained dogs to track feral swine, see Section E(5) in Chapter 2 of USDA (2015). WS would use trained dogs in compliance with WS Directive 2.445. WS would only use trained dogs that are responsive to their handler. For tracking and trailing dogs, WS would only use dogs trained to follow the scent of the target species. WS' personnel could call the dog off the track should the employee determine the dog is following the scent of a non-target species.

Guard Animals

Guard animals are used in damage management to protect a variety of resources, primarily livestock, and can provide adequate protection at times (Andelt 2004, Gehring et al. 2010*a*, VerCauteren et al. 2012). Gehring et al. (2010*b*) provides a historical overview of the use of guard animals to protect livestock from predation. Guard animals (*e.g.*, dogs, burros, and llamas) have proven successful in many sheep and goat operations. Guard dogs have also been used to protect agricultural crops from white-tailed deer (VerCauteren et al. 2005). The effectiveness of guarding animals may not be sufficient in areas where there is a high density of wildlife to be deterred, where the resource (*e.g.*, sheep foraging on open range) is widely scattered, or where the guard animal to resource ratios are less than recommended. WS was instrumental in the introduction and adoption of livestock guarding dogs in the late 1980s and early 1990s and continues to recommend use of livestock guarding dogs where appropriate (Green and Woodruff 1983, Green and Woodruff 1988). WS could recommend the use of guard animals when providing technical assistance. Therefore, WS would not be directly involved with using guard animals.

Hand/Throw Nets

The hand nets and throw nets that WS' personnel could use would be similar to those used during fishing, such as a dip net or hand-thrown net. Generally, dip nets have netting at one end of a long pole that a user uses to scoop up a target animal. A hand-thrown net would be a net that a WS' employee throws over a target animal. Hand-thrown nets typical have weights on the edges of the net.

Cannon/Rocket Nets

The term cannon/rocket net refers to net deployment systems that use rockets, cannons, or compressed air to propel a net over a target area. Similar to other nets, cannon/rocket nets use nylon or cloth nets to capture wildlife. Rocket nets and cannon nets are projectile-type net traps comprised of three to five rockets or cannons and a large net (*e.g.*, 33 x 57 foot with 2-inch square nylon mesh) (Dill and Thornberry 1950, Hawkins et al. 1968, Cox and Afton 1994). When using cannon/rocket nets, the net is fully deployed to determine the capture area when fired. Once the capture zone has been established, the net is rolled up upon itself. In most cases, bait is placed inside the zone to ensure feeding wildlife are captured. When target animals are within the capture zone of the net, the launcher is activated by personnel near the site, which launches the net over the target wildlife.

The user would anchor the rear of the net to 5- or 10-pound boat anchors or would tie the rear of the net with inner tubes to stakes driven into the ground. Smokeless powder or black powder charges propel the rockets or projectiles in the cannons that a user would ignite with an electric squib inside the charge. The user would place the charges inside the rockets or cannon tubes and test the wires with a galvanometer for electrical continuity. The user would unspool at least 200 to 350 feet of 18 or larger gauge wire and connect one end to the charges and the other end to a blasting machine. When an adequate number of target animals gather in front of the net, the user would charge the blasting machine and fire the net. Firing the blasting machine sends an electrical charge down the wire and ignites the charges in the rockets or cannon tubes, which discharge the net. Pneumatic cannon nets deploy under similar methodology as the cannon or rocket nets but do not use smokeless powder or black powder charges to deploy the net. Pneumatic cannons utilize compressed air to deploy the net. The user also remotely discharges the pneumatic air cannon through push button controls wired to a mechanism that releases the compressed air. WS' personnel would primarily use cannon nets in areas where target animals routinely congregate or loaf. In most cases, WS' personnel would use an attractant (*e.g.*, food source) to acclimate target animals to feeding at the location and to position the target animals in an area that ensures the net envelopes the animals.

Drop Nets

Although not a commonly used method for animals, WS could occasionally use drop nets to capture larger mammal species, such as white-tailed deer. Drop nets are nylon or cloth nets that would be suspended above an area actively used by an animal or group of animals where target individuals have been conditioned to feed (Ramsey 1968). WS' personnel would use attractants to ensure target animals were using the location and to ensure the net envelopes target animals. Attractants could include a food source to attract target species and once feeding occurs under the net, the net would be released. WS' personnel could manually drop the net onto target animals or remotely trigger the net to drop onto target animals. When dropped, the net would envelope target animals.

Drop nets require constant supervision by personnel to drop the net when target individuals are present and when animals are underneath the net. This method has limited use due to the time and effort required to condition animals to feed in a location and the required monitoring of the site to drop the net when target wildlife are present. Nets are used to live-capture target individuals and if any non-target animals are present, they can be released on site unharmed. Drop nets allow for the capture of several animals during a single application. Injuries to animals do occur from the use of nets. Injuries to deer occurred when using drop nets with the rate of injury being correlated with the number of deer captured during a single application of the net (Haulton et al. 2001). Similar to other nets, injury rates appear to be correlated with the number of animals captured during a single application of the net (Haulton et al 2001). Non-target animals incidentally captured can be released on site unharmed.

Net Guns

Net guns are another method that WS does not frequently use to live-capture target animals but could in certain situations. Net guns are similar to cannon/rocket nets except the nets are smaller and the nets are propelled from a hand-held launcher similar to a gun. The hand-held gun launches a weighted net over a target animal or animals using a firearm blank or compressed air. Similar to the use of cannon/rocket nets and drop nets, the use of net guns is often associated with the use of an attractant. WS may use net guns to capture individual animals or a small number of animals that WS is unable to capture using other methods.

Denning

Denning is the practice of locating coyote or fox dens and lethally removing the young, adults or both to stop an ongoing predation problem or prevent future depredation of livestock. Denning is used in coyote and fox damage management but is limited because dens are often difficult to locate and den use by the target animal is restricted to about 2 to 3 months during the spring. Coyote depredations on livestock and poultry often increase in the spring and early summer due to the increased food requirements associated with feeding and rearing litters of pups (Till and Knowlton 1983, Till 1992). Removal of pups will often stop depredations even if the adults are not taken (Till 1992). When the adults are taken at or near a known den location, it is customary to euthanize the pups to prevent their starvation because they would be unable to survive on their own. Pups are typically euthanized by digging out the den and euthanizing the pups with sodium pentobarbital (see discussion of sodium pentobarbital). Denning is labor intensive with no guarantee of finding the den of the target animal. Denning is very target-specific and is most often used in open terrain where dens are comparatively easy to find.

Hand Capture and Catch Poles

In certain situations, WS' personnel could use hand capture methods when other live-capture methods are impossible or impractical. For example, WS' personnel may use hand capture methods to capture an animal inside a building or an animal trapped inside a structure. A catch pole is a pole with a tightening grip cable and release with a cable loop that tightens around an animal's neck or body and holds the animal away from the captor. Catch poles allow WS' personnel to restrain animals while keeping them a safe distance away. The device consists of a noose that is usually plastic-coated cable at the end of a long pole. The operator of the pole can place the noose over the head and around the neck of an animal and tighten the noose to prevent the animal's escape.

Cage-type Traps

Cage traps come in a variety of styles to live-capture animals. Cage traps allow target animal species to enter inside the trap through a one-way door or opening but prevent the target animal(s) from exiting the trap. When using cage-type traps, WS' personnel would place a visual attractant or bait inside the trap to attract the target animal or animals. The most commonly known cage-type traps are box traps. Box traps (*e.g.*, Sherman box traps) are usually rectangular and are made from various materials, including metal, wire mesh, plastic, and wood. These traps are well suited for use in residential areas and work best when baited with foods attractive to the target animal. Box traps are generally portable and easy to set-up.

Trap monitors are devices that send a radio signal to a receiver if a set trap is disturbed and alerts field personnel that an animal may be captured. Trap monitors can be attached directly to the trap or attached to a string or wire and then placed away from the trap in a tree or shrub. When the monitor is hung above the ground, it can be detected from several miles away, depending on the terrain in the area. There are many benefits to using trap monitors, such as saving considerable time when checking traps, decreasing fuel usage, prioritizing trap checks, and decreasing the need for human presence in the area. Trap monitors could be used when using cage traps.

Trap monitoring devices could be employed, when applicable, that indicate when a trap has been activated. Trap monitoring devices would allow personnel to prioritize trap checks and decrease the amount of time required to check traps, which decreases the amount of time captured target or non-targets would be restrained. By reducing the amount of time target and non-target animals are restrained, pain and stress can be minimized and captured wildlife can be addressed in a timely manner, which could allow non-target animals to be released unharmed. Trap monitoring devices could be employed where applicable to facilitate monitoring of the status of traps in remote locations to ensure any captured wildlife was removed promptly to minimize distress and to increase the likelihood non-targets could be released unharmed. For more information on cage-type traps and WS' use of those traps, see USDA (2019*a*).

Corral Traps

Corral traps are generally used to capture feral swine. Corral traps for feral swine are generally large circular traps consisting of panels anchored to the ground using steel posts with a door allowing entrance. Side panels are typically woven metal fencing referred to as hog panels or cow panels. The entrances into the traps generally consist of a door that allow entry into the trap but prevents exit. The doors are often designed to allow swine to continually enter the trap, which allows for the possibility of capturing multiple swine. For more information on cage traps and corral traps that WS could use to capture feral swine, see Section E(6)(a) in Chapter 2 of USDA (2015).

Net Traps

Net traps are similar to corral traps except that a heavy-duty netting is used instead of metal livestock panels. The netting is attached to steel posts in a circular design. During the acclimation period, the netting is furled and held above the ground to allow feral swine to pass underneath to feed on bait placed inside the trap. Once feral swine are acclimated to feeding on the bait, the net is lowered to the ground. When set, the netting allows feral swine to walk under the netting to access the bait; however, an apron of netting extends inside the trap, which prevents feral swine from exiting once inside.

Culvert Trap

WS could use culvert traps to live capture black bears in Mississippi when requested by the MDWFP. As their name implies, culvert traps often use part of a steel culvert or similar materials to create a live trap similar to other cage traps. Generally, one end of the culvert trap contains a door that closes when triggered by a bear inside the trap. Culvert traps are often mounted on a trailer so they can be easily transported. The traps are baited with an attractant, usually a food attractant, to lure the bear inside the trap. As the bear forages on the attractant, they trigger a mechanism that closes the door behind them.

Foothold Traps

Foothold traps are mechanical devices designed to capture animals by gripping an animal's foot. A foothold trap consists of a pair of metal jaws, springs, a base to attach the springs and jaws, and a pan triggering mechanism. The springs hold the metal jaws of the trap closed while the pan triggering mechanism, when set, holds the jaws open until an animal steps on the pan, which allows the springs to close the jaws. WS can use foothold traps with rubber pads on the jaws or foothold traps with laminated jaws to reduce injury. WS places foothold traps alongside, or in some situations, in travel ways that target species actively use. Placement of traps is contingent upon the habits of the respective target species, habitat conditions, and presence of non-target animals. Effective trap placement and adjustment and the use and placement of appropriate baits and lures by trained WS' personnel also contribute to the selectivity of foothold traps. An additional advantage is that foothold traps can allow for the on-site release of non-target animals because foothold traps capture animals alive.

WS would primarily use foothold traps to capture larger predatory mammal species, such as coyotes, fox, bobcats, and feral dogs. When setting foothold traps in the ground, personnel dig a shallow depression in the ground that is slightly larger than the trap being set. The depression is generally prepared just deep enough so, when placing the trap in the depression, the pan of the trap is at or just below the soil surface. Typically, the trap attaches to an anchoring stake or stakes by a chain. Personnel drive the anchoring stake or stakes into the depression to hold the trap. Generally, once placing the anchoring stake or stakes in the depression, personnel sift loose dirt into the depression, and they then press the set trap into the bottom of the depression to ensure the trap does not wobble. Personnel generally place a pan cover over the pan to prevent objects from getting under the pan and preventing it from depressing when a target animal applies pressure. After placing the pan cover, personnel sift loose dirt over the top of the trap to conceal the trap. When using foothold traps, personnel generally make a dirt-hole set, cubby set, or flat set.

Dirt-hole sets generally consist of a small hole dug into an embankment, the base of a plant, or other natural feature. The hole slants back about six to eight inches deep into the embankment or under the backing. Personnel then place the foothold trap, as described previously, so the center of the trap is approximately seven inches from the hole for fox and 12 inches back from the hole for coyotes. Often, personnel will place bait or lure at the back of the hole, so the target animal triggers the trap when they step in front of the hole to investigate. When using bait, personnel often obscure the entrance to the hole with grass or other light debris to prevent raptors from seeing the bait from the air. Cubby sets are similar to a dirt-hole set except instead of digging a hole in dirt, personnel create a "*hole*" using rocks or other debris with only one entrance. Personnel place the bait or lure inside the "*hole*" and place the trap in front of the entrance. As a target animal approaches to investigate the bait or lure in the "*hole*", they trigger the trap. Personnel generally use cubby sets for smaller predator species, such as raccoons and bobcats.

A flat set is similar to a dirt-hole set but personnel do not dig a hole to place bait or lure in. In place of the hole, personnel use a chunk of wood, old bone, or other visual attractor to get the attention of the target animal. Personnel then place a few drops of lure or squirt coyote urine (or urine of another target species) on the attractor. Personnel then place the foothold trap, as described previously, in front of the attractor approximately six inches.

Translocation

WS' personnel could use live-capture methods to capture target animals and then translocate those animals to other areas. WS would release animals in habitat associated with the species and only on property where the landowner has agreed to allow WS to release the animal. Translocation would only occur when authorized by the MDWFP.

Unmanned Aerial Vehicles

UAVs have several applications to prevent or reduce damage caused by target species. UAVs are receiving increasing attention as a wildlife management tool (Watts et al. 2010, Koh and Wich 2012, Martin et al. 2012, Lyons et al. 2017, Wang et al. 2019). WS' personnel could use UAVs to inspect areas where target species are causing damage, collect images or videos to compare before and after removal efforts have been conducted, or locate target species. The information obtained during these flights could help WS make decisions on where to concentrate efforts. For example, WS could use thermal cameras attached to UAVs to locate specific animals, such as feral swine. Unmanned aircraft generally produce less noise, use less fuel, and are generally less expensive to operate than manned aircraft (Watts et al. 2010). When using UAVs, WS would adhere to all federal, state, and local laws. WS would also follow the guidelines established in the WS' Small Unmanned Aircraft System Flight Operations Procedures manual.

Aerial Operations

WS could use aircraft during a variety of activities to aid with managing damage caused by mammals in Mississippi. Aircraft are a commonly used tool for evaluating and monitoring damage and establishing population estimates and locations of various species of animals. WS could use fixed-winged aircraft and/or helicopters to conduct surveys to locate and/or estimate the number of animals in areas of the state. WS uses aerial surveying throughout the United States to monitor wildlife damage and/or populations of large-bodied mammals and various bird species. Any animal species large enough to see from a moving aircraft could be surveyed using this method. The WS program aircraft-use policy helps ensure that aerial surveys are conducted in a safe and environmentally sound manner, in accordance with federal and state laws. Pilots and aircraft must also be certified under established WS program procedures and policies.

Aerial telemetry is used in research projects studying the movements of various animal species. WS' personnel may place radio-transmitting collars on selected individuals of a species and then monitor their movements over a specified period. Whenever possible, WS' personnel typically attempt to locate the research subject using a hand-held antennae and radio receiver. However, occasionally animals will make large movements that prevent biologists from locating the animal from the ground. In these situations, WS can utilize either fixed wing aircraft or helicopters and elevation to conduct aerial telemetry and locate the specific animal wherever it has moved to.

Shooting from an aircraft is a commonly used damage management method for certain mammal species that are causing damage or posing a threat of damage. In Mississippi, WS primarily used aerial shooting to target feral swine causing damage, but WS could use firearms from helicopters to target coyotes, white-tailed deer, and other similar mammal species. Aerial shooting consists of visually sighting target animals in the problem area and personnel shooting the animal from the aircraft. Local depredation problems can often be resolved quickly through aerial shooting. For example, aerial shooting is one of the preferred damage management methods for reducing feral swine damage because local swine populations can quickly be removed when weather and habitat conditions are favorable. WS could also use aerial shooting for disease surveillance. Cain et al. (1972) rated aerial shooting as "*very good*" in effectiveness for problem solving, safety, and lack of adverse environmental impacts. Wagner (1997) and Wagner and Conover (1999) found that aerial shooting might be an especially appropriate tool as it reduces risks to non-target animals and minimizes contact between damage management operations and recreationists. Aerial shooting is mostly species-selective (there is a slight potential for misidentification).

Good visibility and relatively clear and stable weather conditions are required for effective and safe aerial shooting. Air temperature (high temperatures), which influences air density, affects low-level flight safety and may restrict aerial shooting activities. Tree cover can limit visibility from the aircraft, thus making it difficult for aerial shooting to be effective. However, aerial shooting can be extremely effective in habitats that are open or have broken timber. Ground crews are often used with aerial operations for safety reasons. Ground crews can also assist with locating and recovering target animals, as necessary. Section E(4) in Chapter 2 of USDA (2015) provides additional information on the use of aerial shooting.

Scout Animals

Judas animals involve attaching a radio and/or GPS transmitter to an animal 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 animal*" has joined other animals of the same species, those animals may be lethally removed or captured to become additional Judas animals. The original animal with the transmitter may be lethally removed or released to join additional animals of the same species and the process repeated. WS would only capture, collar, and use animals as Judas animals on species that usually congregate in large groups, such as feral swine. If a Judas animal sustains 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 animals in compliance with all WS Standard Operating Procedures and WS' directives. Section E(2)(a) in Chapter 2 of USDA (2015) provides additional information on the use of feral swine as Judas animals.

Enclosed Foothold Trap

Another type of cable restraint available to live-capture raccoons and opossum requires the target animal to reach inside the opening of an enclosed trap to reach the bait. The bait is generally inserted onto or near the trigger, which is recessed approximately 2 to 3 inches inside the trap. The trigger generally requires the target animal to pull on the trigger, but some designs allow the trigger to be pushed or pulled. When the target animal trips the trigger inside the enclosed trap the spring that was being held compressed by the trigger is released causing a cable or metal arm to close quickly over the animal's foot. The foot of the animal is held inside the enclosed trap. The opening into the enclosed trap is narrow (normally 1.5 inches in diameter), which prevents animals much larger than a raccoon from accessing the trigger. The enclosed foothold trap can be buried underground with only the opening exposed to simulate a hole in the ground or placed above ground. The enclosed foothold trap is anchored to the ground or nearby vegetation.

Immobilizing Drugs

WS could administer chemicals (*e.g.*, Telazol, Ketamine, or a mixture of Ketamine and Xylazine) to immobilize mammals in certain instances (*e.g.*, affixing a radio and/or GPS transmitter on an animal to be used as a Judas animal, to relocate a black bear). For WS' personnel to administer immobilization chemicals to a target mammal, the target animal would first need to be captured using live-capture methods (*e.g.*, live-capture traps, nets). WS' personnel would administer immobilizing drugs through hand injection or jab stick. WS could also administer immobilization chemicals to target species through injection using a projectile (*e.g.*, dart gun).

Ketamine (Ketamine Hydrochloride) is a dissociative anesthetic that is available to capture wildlife. It is used to eliminate pain, calm fear, and allay anxiety. Ketamine is possibly the most versatile drug for chemical capture, and it has a wide safety margin (USDA 2019*b*). When used alone, this drug may produce muscle tension, resulting in shaking, staring, increased body heat, and, on occasion, seizures. Usually, ketamine is combined with other drugs, such as xylazine. The combination of such drugs is used to control an animal, maximize the reduction of stress and pain, and increase human and animal safety. WS anticipates using ketamine infrequently. The use of ketamine would primarily be associated with immobilizing mammals as part of research projects, such as attaching tracking devices to juveniles for movement studies or to take biological measurements. In addition, WS could occasionally use ketamine to immobilize feral swine to attach tracking collars or to immobilize a target animal for translocation. Trained WS' personnel would administer ketamine directly to the target animal through injection from a syringe after live-capture.

Telazol is a combination of equal parts of tiletamine hydrochloride and zolazepam hydrochloride (a tranquilizer). Telazol produces a state of unconsciousness in which protective reflexes, such as coughing and swallowing, are maintained during anesthesia. Schobert (1987) listed the dosage rates for many wild and exotic animals. Before using telazol, the size, age, temperament, and health of the animal are considered. Following a deep intramuscular injection of telazol, onset of anesthetic effect usually occurs within 5 to 12 minutes. Muscle relaxation is optimum for about the first 20 to 25 minutes after the administration, and then diminishes. Recovery varies with the age and physical condition of the animal and the dose of Telazol administered, but usually requires several hours. Telazol is usually used for larger animals.

Xylazine is a sedative (analgesic) that calms nervousness, irritability, and excitement, usually by depressing the central nervous system. WS often uses a combination of xylazine and ketamine to produce a relaxed anesthesia. When using ketamine/xylazine combinations, xylazine will usually overcome the tension produced by ketamine, resulting in a relaxed, anesthetized animal (USDA 2019*b*). This reduces heat production from muscle tension but can lead to lower body temperatures when working in cold conditions.

Butorphanol-Azaperone-Medetomidine (BAM) is an anesthetic, belonging to the cyclohexane group of drugs that creates a dissociation between the thalamoneocortical and limbic systems (dissociative anesthetic). BAM is a mixture of Butorphanol (sedative), Azaperone (tranquilizer) and Medetomildine ($alpha_2$ agonist with sedative and analgesic properties) that antagonizes an opioid and $alpha_2$ -adrenergic antagonist resulting in chemical immobilization (Kreeger and Arnemo 2012). BAM can produce a slow induction and depressed respiration leading to muscle relaxation (Mich et al. 2007, Kreeger and Arnemo 2012). The advantage in using BAM on wildlife is the fast recovery and amnesic properties of this drug mixture (Wolf et al. 2008). For this reason, BAM may be a preferable option to mitigate stress and chemical-induced side-effects (like hypoxemia) often present with other cyclohexanes.

Nalbuphine HCL, Medetomidine HCL, and Azaperone tartrate (NAM) is a combination of three drugs that utilizes the opiate nalbuphine (k agonist/u antagonist) for use in sedation. Nalbuphine is a lesser opioid and generates a low risk of abuse (KuKanich and Wiese 2015). Medetomidine provides a smooth induction and can be potentiated by certain opioids, such as nalbuphine (Wolfe et al. 2008). However, when these two drugs combine with azaperone this creates an immobilizing effect that reduces stress, relaxes muscles, and facilitates sedation (KuKanich and Wiese 2015). The advantage of using NAM on wildlife is the quick recovery from depressed respiration with limited withdraw unlike the effects produced with other chemical immobilizers like BAM (Wolfe et al. 2016). NAM can be administered using low volume and the effects are reversible (Wolfe et al. 2016). This drug is not regulated by the United States Drug Enforcement Administration; therefore, it is not subjected to the same constraints as scheduled drugs (United States Drug Enforcement Administration 2019).

Repellents

Repellents are usually products the EPA has classified as general use pesticides, which means the public can purchase and use those products without the need for a pesticide applicators license. Those products are commercially available and people without a pesticide applicators license can purchase and use those products. The active ingredient of most repellents for mammals are generally naturally occurring substances, such as sand (Silica) mixed with a non-toxic carrier for application to surfaces, capsaicin, or putrescent whole egg solids, that the EPA has classified as general use pesticides, which means the public can purchase and use those products without the need for a pesticide applicators license. By definition, general use pesticides are those products the EPA has determined would not generally cause unreasonable adverse effects on the environment when applicators use those products pursuant to the label. Anthraquinone is the active ingredient in many commercially available bird repellents that may have some applicability as a repellent for raccoons and other mammals (Johnson et al. 2022). However, products containing anthraquinone as a repellent are currently not available for mammal species.

People generally apply taste repellents directly to affected resources, which elicits an adverse taste or texture response when the target animal tastes or ingests the treated resource or the ingestion of the repellent causes temporary sickness (*e.g*., nausea). Products containing coyote urine or other odors associated with predatory wildlife are intended to elicit a fright response in target wildlife by imitating the presence of a predatory animal (*i.e*., wildlife tend to avoid areas where predators are known to be present). If repellents are available for use in Mississippi to reduce damage caused by mammals, WS could employ or recommend for use those repellents that were available. WS' personnel would follow all label requirements when using repellents. WS anticipates using repellents infrequently.

GonaCon™

WS has developed an immunocontraceptive vaccine called GonaCon™ that contains the active ingredient Gonadotropin releasing hormone (GnRH) conjugated to a mollusk-derived carrier protein, against endogenously produced GnRH. GnRH is a naturally occurring hormone that stimulates production of sex hormones, such as luteinizing hormone and follicle-stimulating hormone, which regulate gamete and steroid hormone production by the reproductive organs of vertebrates. When injected into a target animal, GonaCon™ induces the body to make antibodies against its own GnRH causing infertility. GonaCon™ is registered with the EPA for use in female wild or feral equids (*Equus* spp.), white-tailed deer, and prairie dogs (*Cynomys* spp.) (USDA 2022*b*). WS could use GonaCon™ to manage a localized white-tailed deer herd or wild/feral equids, such as a white-tailed deer herd confined inside a perimeter fence at a facility. Prairie dogs do not occur in Mississippi. Application is limited to WS personnel, state wildlife management personnel, or persons working under their authority. Additionally, 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.

For white-tailed deer, single 1-milliliter (mL) doses of GonaCon™ – Deer (EPA Reg. No. 56228-40) are packaged and pre-loaded in 3-mL plastic syringes, which the applicator administers by hand injection at least 2 to 3 months prior to the onset of the breeding season. Therefore, WS must live-capture white-tailed deer prior to administering GonaCon™ and the applicator must tag vaccinated deer. Applicators hand inject GonaCon™ into a large muscle mass using a 1.5-inch 18-gauge or 19-gauge stainless steel hypodermic needle. Application by remote darting is done by using a 2 cubic centimeter (cc) dart with a 1.25- or 1.5-inch 14-gauge gelatin barb needle. Applicators transfer 1-mL of GonaCon™ from the preloaded syringe into the dart. In studies, researchers injected GonaCon™ into the upper hind limb of white-tailed deer and found that a single vaccination can induce infertility for multiple years (Miller et al. 2000, Gionfriddo et al. 2011).

For equids, single 2-mL doses of GonaCon™ – Equine (EPA Reg. No. 56228-41) are packaged and pre-loaded in 3-mL plastic syringes, which the applicator administers by hand injection, jabstick, or remote darting at least 2 to 3 months prior to the onset of the breeding season. Applicators inject GonaCon™ into a large muscle mass. When hand injecting, applicators would use a 1.5-inch 18-gauge or 19-gauge stainless steel hypodermic needle. When using a jabstick, applicators would transfer 2-mL of GonaCon™ from the preloaded syringe into a 1.5-inch 14-gauge stainless steel hypodermic needle. Applicators using remote darting would transfer 2-mL of GonaCon™ from the preloaded syringe into a 2-cc dart with a 1.25- or 1.5-inch 14-gauge gelatin barb needle.

To improve efficacy or if a longer contraceptive effect is desired, a booster vaccination may be administered to marked animals by hand injection or remote darting 90 days or more after the first injection or annually. The effects of the vaccine may wear off the second year or sometimes longer, and vaccinated females may once again become fertile. However, re-immunization with GonaCon™ can extend infertility. There is a possibility that some vaccinated females will become permanently sterile.

Attractants

WS can use attractants, such as baits, scents or lures, to increase the efficacy of other methods by enticing an animal to investigate a particular location where WS has capture methods deployed or to encourage an animal to enter inside a trap. Food attractants consist of food items that are preferred by target animals. For example, WS' personnel could use whole eggs inside a box trap set to capture skunks or use marshmallows to encourage a raccoon to enter a trap. Lures could include liquid attractants that mimic another target animal. For example, coyote urine could be used to attract other coyotes.

Scents or lures are usually a blend of natural substances, which could include urine, musk, organs (glands), and essential oils (Turkowski et al. 1983, Kimball et al. 2000). However, attractants can also be synthetically based. When targeting mammalian predators, WS could use visual attractants (*e.g.*, feathers) to entice an animal to investigate a particular location. WS would use relatively small quantities of baits, scents, and lures to attract a target animal or animals.

II. LETHAL METHODS

In addition to the use of non-lethal methods, WS' personnel could also use lethal methods. When required, the lethal removal of mammals by WS would only occur when authorized by the MDWFP and only at levels authorized. In addition, WS would only use those lethal methods authorized by the MDWFP.

Body-grip Traps

Body-grip traps are designed to cause the quick death of the animal that activates the trap. Body-grip traps consist of a pair of rectangular wire frames that close like scissors when triggered, killing the captured animal with a quick body blow. For body-grip traps, the traps should be placed to ensure the rotating jaws close on either side of the neck of the animal to ensure a quick death. WS' personnel would primarily use body-grip traps to target medium to smaller predatory mammal species, such as raccoons. Body-grip traps would be available for use by all entities.

WS can minimize the risk of capturing non-target animals by selecting the appropriate trap size for the target animal, by placing traps in areas actively used by a target species, adjusting the location of the trigger, selection of the proper bait, lure or attractant, and appropriate trap placement. Choosing appropriately sized traps for the target species can also exclude non-target animals by preventing larger non-target animals from entering and triggering the trap. WS can also minimize the risk of capturing a non-target animal by using recessed sets (placing trap inside a cubby, cage, or burrow) or restricting openings. In addition, WS can offset the trigger to allow non-target animals to pass through body-grip traps without capture.

Cable Devices

Cable devices consist of a cable or wire that a manufacturer or WS' personnel have fabricated with a cable or wire loop at one end of the device. WS' personnel or the manufacturer often fabricates the end of the cable opposite of the loop to work as an anchor to hold the cable device. WS' personnel would position the loop to close around the neck, torso, leg, or foot of a target mammal as the animal moves through the loop. WS can use cable restraints wherever a target animal moves through a restricted travel lane (*e.g.*, trails through vegetation). When an animal moves forward into the loop formed by the cable, the noose tightens, and the animal is held. USDA (2019*e*) provides more information on cable devices and WS' use of cable devices to capture target animals. Appendix F identifies restrictions that WS would follow when using cable devices to target coyotes and Appendix G identifies restrictions that WS would follow when using cable devices to target feral swine.

Firearms

WS' personnel could use firearms to lethally remove and/or haze target animals. Firearms could include the use of rifles, handguns, and shotguns to lethally remove target mammal species. Firearms are mechanical methods that WS could use to remove mammals lethally and to reinforce the noise associated with non-lethal methods, such as pyrotechnics or propane cannons. In addition, the noise associated with discharging a firearm can disperse animals. As appropriate, WS' personnel would use suppressed firearms to minimize noise impacts. In addition, WS' personnel could use firearms to euthanize live-captured target animals. Methods and approaches used by WS in association with firearms may include use of illuminating devices, bait, firearm suppressors, and night vision/thermal equipment. WS' personnel would retrieve the carcasses of animals to the extent possible and would dispose of the carcasses in accordance with WS Directive 2.515. As noted for pyrotechnics, some commercially available pyrotechnics require the use of a shotgun to fire the pyrotechnic. WS' firearm use and safety would comply with WS Directive 2.615.

Shooting can also be used in conjunction with an illumination device at night, which is especially useful for nocturnal mammals. Spotlights may or may not be covered with a red lens, which nocturnal animals may not be able to see, making it easier to locate them undisturbed. Night shooting may be conducted in sensitive areas that have high public use or other activity during the day, which would make daytime shooting unsafe. The use of night vision and Forward Looking Infrared (FLIR) devices can also be used to detect and shoot animals at night and is often the preferred equipment due to the ability to detect and identify animals in complete darkness. Night vision and FLIR equipment aid in locating wildlife at night when wildlife may be more active. Night vision and FLIR equipment could be used during surveys and in combination with shooting to remove target animals at night. Those methods aid in the use of other methods or allow other methods to be applied more selectively and efficiently. Night vision and FLIR equipment allow for the identification of target species during night activities, which reduces the risks to non-target animals and reduces human safety risks. Night vision equipment and FLIR devices only aid in the identification of wildlife and are not actual methods of removal. The use of FLIR and night vision equipment to remove target animals would increase the selectivity of direct management activities by targeting those animals most likely responsible for causing damage or posing threats.

Recommendation of Harvest During Hunting and/or Trapping Seasons

In limited situations, WS' personnel could recommend that a person allow sport hunting and/or trapping on their property when people can legally harvest the target species during a hunting and/or trapping season, such as allowing hunters to harvest white-tailed deer during the appropriate hunting season.

Injection of Euthanasia Chemicals after Live Capture

WS could use several chemical methods to euthanize animals live captured using other methods. WS' personnel would use euthanasia chemicals in accordance with WS Directive 2.505. WS would dispose of carcasses euthanized in accordance with WS Directive 2.515. Trained WS personnel could use sodium pentobarbital, potassium chloride, and carbon dioxide to euthanize animals. Sodium pentobarbital is a barbiturate that WS could use to euthanize animals. Sodium pentobarbital rapidly depresses the central nervous system to the point of respiratory arrest. WS would only administer sodium pentobarbital after live capturing a target animal and only after WS properly immobilized the animal to allow for direct injection. There are United States Drug Enforcement Administration restrictions on who can possess and administer this drug. In accordance with United States Drug Enforcement Administration and state regulations, only WS' personnel certified in the use of euthanasia chemicals would use sodium pentobarbital and its dilutions (*e.g.*, Beuthanasia-D, Fatal-Plus) for euthanasia.

Beuthanasia®-D combines pentobarbital with another substance to hasten cardiac arrest. Intravenous and intracardiac are the only acceptable routes of injection. As with pure sodium pentobarbital, intracardiac injections with Beuthanasia®-D are only acceptable for animals that are unconscious or deeply anesthetized. With other injection routes, there are concerns that the cardiotoxic properties may cause cardiac arrest before the animal is unconscious. It is a Schedule III drug, which means it can be obtained directly from the manufacturer by anyone with a United States Drug Enforcement Administration registration. However, Schedule III drugs are subject to the same security and record-keeping requirements as Schedule II drugs.

Fatal-Plus® combines pentobarbital with other substances to hasten cardiac arrest. Intravenous is the preferred route of injection; however, intracardiac is acceptable as part of the two-step procedure used by WS. Animals are first anesthetized and sedated using a combination of ketamine/Xylazine and once completely unresponsive to stimuli and thoroughly sedated, Fatal-Plus® is administered. Like Beuthanasia®-D, it is a Schedule III drug requiring a United States Drug Enforcement Administration registration for purchase and is subject to the security and record-keeping requirements of Schedule II drugs.

WS anticipates using sodium pentobarbital and its dilutions infrequently. Trained WS' personnel would administer sodium pentobarbital and its dilutions directly to the target animal through injection from a syringe after live-capture. There are secondary hazards associated with scavengers feeding on carcasses euthanized with sodium pentobarbital. Therefore, WS would dispose of all animals euthanized using sodium pentobarbital and all of its dilutions through deep burial to prevent secondary poisoning of scavenging animals and introduction of those chemicals to non-target animals.

Potassium chloride is another euthanasia chemical that WS could use to euthanize target mammal species after live capture. WS would administer potassium chloride through direct injection with a syringe after anesthetizing the target animal. Animals euthanized with sodium chloride experience cardiac arrest followed by death. Like other euthanasia chemicals, WS anticipates using potassium chloride infrequently. WS would dispose of all animals euthanized using potassium chloride through deep burial.

Carbon Dioxide for Euthanasia

Carbon dioxide is another method of euthanasia that WS could use to euthanize target mammal species. After live capture, WS would place a target animal or animals inside a sealed chamber. WS would slowly release carbon dioxide gas into the chamber. As the carbon dioxide levels increase in the chamber, the animal dies from hypoxia. Like other euthanasia chemicals, WS anticipates using carbon dioxide infrequently.

Gas Cartridge

The EPA has approved the use of products containing sodium nitrate/charcoal (hereafter, gas cartridges)[7] as a fumigant for burrowing rodents and denning mammal species, such as woodchucks and striped skunks. When using gas cartridges, WS' personnel would locate and plug all entrances to the burrow system or den except the entrance selected for treatment. WS' personnel would then use a nail to puncture a hole into the fuse-end cap of the gas cartridge to insert the fuse as directed by the label. WS' personnel would hold the cartridge away from their face and body and then light the fuse. WS' employees would place the gas cartridge, fuse-end first, as far into the burrow or den as possible and then seal the burrow or den entrance immediately with soil. If smoke escapes through cracks in the ground, WS' personnel would cover the cracks with additional soil. The fuse will ignite the sodium nitrate, an oxidizer, which accelerates the combustion of charcoal producing carbon monoxide (CO) gas when burned

[7]The primary ingredients of gas cartridges are sodium nitrate and charcoal, but they also contain fuller's earth and borax (Johnston et al. 2001, USDA 2019*h*).

(USDA 2019*h*). Carbon monoxide gas is highly toxic to wildlife and people at high concentrations.

Because WS' personnel would seal burrow and den entrances to trap the carbon monoxide gas inside the burrow system or den, WS anticipates target animals to succumb to the effects of the carbon monoxide gas underground (Matschke and Fagerstone 1984). Therefore, carcasses of target animals are not likely to be available above ground for scavenging by animals or handling by the public.

WS' personnel would follow all applicable label requirements of gas cartridges for use to treat the entrances of burrows and dens. Pursuant to WS Directive 2.210, WS' personnel would conduct all management activities in accordance with applicable federal, state, and local laws and regulations. In addition, WS' personnel would conduct activities pursuant to applicable WS' Directives (see WS Directive 1.101). WS' use of gas cartridges would occur pursuant to WS Directive 2.401, WS Directive 2.405, and WS Directive 2.465. WS would only use gas cartridges that the MDAC has approved for use in Mississippi.

APPENDIX D. POPULATION IMPACTS TO TARGET MAMMAL SPECIES AND NON-TARGET ANIMAL SPECIES

I. EFFECTS OF THE ALTERNATIVE APPROACHES ON THE POPULATIONS OF TARGET MAMMAL SPECIES

Mammal species play a vital role in a healthy ecosystem; therefore, a common issue when addressing damage caused by mammal species is the potential impacts of management actions on the populations of those species, especially when using lethal methods. Maintaining viable populations of native species is a concern of the public and state, tribal, and federal agencies, including WS. If WS implemented Alternative 1, Alternative 2, or Alternative 3, WS could conduct and/or recommend that others conduct activities that could disperse, exclude, capture, or lethally remove target mammal species depending on the alternative approach WS selected and implemented. Appendix C identifies and discusses the methods that WS could consider when formulating strategies to resolve damage caused by target mammal species in Mississippi when someone requests such assistance. If WS implemented Alternative 4, WS would not conduct any activities in Mississippi involving target mammal species. This section evaluates the magnitude of effects on the populations of target mammal species that could occur if WS implemented one of the four alternative approaches.

➢ Population Impact Analyses of the Alternative Approaches

As discussed in Section 3.1 of the EA, the MDWFP is the entity responsible for managing the wildlife in Mississippi. Similarly, tribes are responsible for managing mammal species on their lands. Through ongoing communication with the MDWFP, WS can consider the activities of other agencies and private entities to the extent that those agencies know those activities occur. WS does not typically conduct direct damage management activities concurrently with other governmental or private entities at a location but may conduct damage management activities at adjacent sites within the same period.

WS' actions would be occurring simultaneously over time with other natural processes and human generated changes that are currently taking place. These activities include, but are not limited to

- Natural mortality of mammals
- Human-induced mortality through vehicle strikes
- Human-induced mortality of mammals through private damage management activities
- Human-induced mortality through regulated harvest
- Human and naturally induced alterations of wildlife habitat
- Annual and perennial cycles in wildlife population densities

All those factors play a role in the dynamics of mammal populations. WS' employees use the WS Decision Model to evaluate damage occurring (including other affected elements and the dynamics of the damaging species) and to determine appropriate strategies to minimize effects on environmental elements. After WS' personnel apply damage management actions, they subsequently monitor and adjust/cease damage management actions (Slate et al. 1992). This process allows WS to take into consideration other influences in the environment, such as those listed above, in order to avoid significant adverse impacts on target species.

With management authority over the target mammal species, the MDWFP could adjust take levels, including the take by WS, to achieve population objectives for mammals. Consultation and reporting of take by WS would ensure the MDWFP had the opportunity to consider the activities conducted by WS. As stated previously, WS would not use or recommend lethal methods available as population management tools over broad areas. WS would use and recommend lethal methods to reduce the number of mammals present at a location where damage was occurring by targeting those mammals causing damage or posing threats; therefore, the intent of lethal methods would be to manage those mammals causing damage and not to manage entire mammal populations.

The magnitude of impact from lethal take can be determined either quantitatively or qualitatively. Quantitative determinations may rely on population estimates, allowable removal levels, and actual removal data. Qualitative determinations may rely on population trend data and harvest trend data, when available. Several sources, including published literature and harvest data, can provide information on mammal populations and trends. The potential impacts of conducting the alternative approaches on the populations of target mammal species occurs below for each alternative.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

If WS implements Alternative 1, WS would be available to provide both technical assistance and direct operational assistance to those persons requesting assistance with managing damage and threats caused by target mammal species in the state. The effects on the populations of target mammal species associated with WS providing technical assistance during the implementation of Alternative 1 would be similar to those effects discussed for Alternative 3. Therefore, to reduce redundancy, the effects associated with WS providing technical assistance that would occur if WS implements Alternative 1 occur in the discussion for Alternative 3.

When providing direct operational assistance, WS could employ those methods described in Appendix C in an adaptive approach that would integrate methods to reduce damage and threats associated with mammals effectively. WS' personnel would use the WS Decision Model (see WS Directive 2.201) to identify the most appropriate damage management strategies and their impacts. If WS implemented Alternative 1, WS' personnel could choose to use any of the methods discussed in Appendix C when using the WS Decision Model to formulate strategies. Therefore, implementation of Alternative 1 would allow WS' personnel to consider the widest range of methods available when formulating strategies to resolve requests for assistance associated with mammals. When practical and effective, WS' personnel would give preference to non-lethal methods pursuant to WS Directive 2.101.

A common concern is whether damage management actions would adversely affect the population of a mammal species, especially when WS and other entities use lethal methods.

Therefore, the evaluation of potential effects on the populations of target mammal species for Alternative 1 will primarily focus on WS' use of lethal methods because WS' personnel could use lethal methods to remove an individual mammal or a group of mammals to alleviate damage. WS would only target an individual mammal, or a group of mammals, identified as causing damage or posing a threat to human safety. The number of mammals that WS could remove from a population using lethal methods 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. In addition, WS would only take mammals when authorized by the MDWFP when conducting activities on tribal land, by the tribe, and only at authorized levels.

If WS implemented Alternative 1, WS could lethally remove several mammal species, which could potentially effect the populations of target mammal species. The basis for the analysis to determine the magnitude of impacts on the populations of target mammal species from the use of lethal methods would be a measure of the number of individuals lethally removed in relation to the abundance of that species. Magnitude may be determined either quantitatively or qualitatively. Quantitative determinations may rely on population estimates, allowable removal levels, and actual removal data. Qualitative determinations may rely on population trend data, when available. Information on mammal populations and population trend data can be available from several sources including fur harvest reports, surveys, and available literature.

WS' personnel would only use lethal methods after the appropriate property owner or manager agreed to allow WS to use those methods on property they own or manage. WS would only use lethal methods after the MDWFP or a tribe authorized lethal take, when required. In addition, people can address damage or threats of damage caused by many of the target mammal species independent of assistance from WS. People can also harvest many of the mammal species during annual hunting and/or trapping seasons in the state. One concern is that damage management activities conducted by WS would affect the ability of people to harvest mammal species during the hunting and trapping seasons by reducing local populations either through lethal removal or dispersal techniques. The potential impacts to the populations of mammals from the implementation of Alternative 1 occur below for each species.

Nine-banded Armadillo Population Information and Effects Analysis

Armadillos occur statewide across Mississippi throughout the year in suitable habitat (Layne 2003). The number of nine-banded armadillos present in Mississippi is unknown. In general, population densities for armadillos can range from 0.004 to 1.4 armadillos per acre with an average of 0.27 armadillos per acre (Mengak 2005). The estimated land area of Mississippi is 46,923.96 square miles (United States Census Bureau 2023), which is approximately 30,031,334 acres. Using a general population density estimated at 0.004 to 1.4 armadillos per acre, the statewide population could range from approximately 120,000 armadillos to approximately 42 million armadillos. With an average of 0.27 armadillos per acre, the estimated statewide population could be 8.1 million armadillos. As stated previously, the actual number of armadillos in the state is currently unknown.

From FY 2019 through FY 2023, WS has lethally removed an average of 21 armadillos annually in Mississippi using firearms. The highest level of removal occurred during FY 2020 when WS' personnel lethally removed 34 armadillos using firearms. Based on previous requests for assistance received by WS and in anticipation of additional requests for assistance, WS could lethally remove up to 200 armadillos annually in the state. In addition to the intentional lethal removal of armadillos to alleviate damage caused by armadillos, WS could occasionally lethally remove armadillos unintentionally while conducting damage management activities targeting other animals. Although WS' personnel could lethally remove armadillos unintentionally during other damage management activities, the lethal removal of armadillos is not likely to exceed 200 armadillos. Armadillos are an unregulated species in the state and people can remove armadillos at any time. The number of armadillos lethally removed by other entities to alleviate damage is currently unknown.

Given the range of population estimates in the state, the lethal removal of 200 armadillos by WS annually would represent 0.2% of the statewide population based on a population estimated at 120,000 armadillos if the overall population remains at least stable. Although the number of armadillos lethally removed by other entities in the state to alleviate damage is unknown, the lethal removal of armadillos, including the proposed removal of up to 200 armadillos annually by WS, is likely of low magnitude when compared to the actual statewide population of armadillos.

Virginia Opossum Population Information and Effects Analysis

Virginia opossums are common throughout Mississippi in appropriate habitat (Gardner and Sunquist 2003). Population estimates for opossum in the state are not available. Therefore, the analysis will provide an estimated population based on the best available information for opossum to evaluate the magnitude of lethal removal. In Virginia, Seidensticker et al. (1987) noted there was a wide variation in opossum numbers, in what they considered excellent habitat for the species. Those variations occurred seasonally and in different years. However, the mean density during the study was 10.1 opossum per square mile with a range of 1.3 opossum per square mile to 20.2 opossum per square mile (Seidensticker et al. 1987). This was comparable to other opossum population densities in similar habitats in Virginia. Verts (1963) found a density estimate of 10.1 opossum per square mile in farmland areas of Illinois, while Wiseman and Hendrickson (1950) found a density of 6.0 opossum per square mile in mixed pasture and woodlands in Iowa. However, VanDruff (1971) found opossum densities in waterfowl nesting habitat as high as 259 opossum per square mile.

The land area of Mississippi covers approximately 46,923.96 square miles. Using a mean density of 10.1 opossum per square mile found by Seidensticker et al. (1987) in Virginia, the estimated population would be 474,000 Virginia opossum. Using the range of opossum densities found by Seidensticker et al. (1987) of 1.3 opossum per square mile to 20.2 opossum per square mile, the statewide population would range from a low of 61,000 Virginia opossums to a high of nearly 948,000 Virginia opossum.

Opossums in Mississippi are a species that people can harvest during annual hunting and trapping seasons. At this time, hunters and trappers can harvest opossums during the open seasons with no limit on the number of opossum that people can harvest during those seasons. In addition, people can lethally remove Virginia opossums that are causing damage or posing a threat of damage when authorized by the MDWFP. From the 2018-2019 trapping season through the 2022-2023 trapping season, trappers in Mississippi harvested an average of 7,166 Virginia opossum annually in the state. The number of opossums that hunters harvested during the annual hunting season and the number of opossums lethally removed by other entities to alleviate damage or threats of damage is unknown in the state.

Based on previous requests for assistance received by WS and in anticipation of additional requests for assistance, WS could lethally remove up to 150 Virginia opossums annually in the state during activities to alleviate damage, including activities that could lethally remove Virginia opossum unintentionally while targeting other mammal species. Given the range of population estimates in the state, the lethal removal of 150 opossum by WS annually would represent from 0.02% to 0.3% of the estimated statewide population if the overall population remains at least stable. Combining the average annual harvest of 7,166 opossum by trappers and the anticipated annual removal by WS of 150 Virginia opossums would represent 0.8% to 12.0% of a statewide population that ranged from 61,000 to 948,000 Virginia opossums.

The MDWFP allows people to harvest an unlimited number of Virginia opossums during the annual hunting and trapping season in the state, which provides an indication the population of opossums is not likely to decline from overharvest. Although the number of Virginia opossum lethally removed in the state during the annual hunting season and for damage management is unknown, the lethal removal of opossum, including the proposed removal of up to 150 opossums annually by WS, would be of a low magnitude when compared to the actual statewide Virginia opossum population. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of opossum annually would have no effect on the ability of those persons interested to harvest opossum during the regulated harvest season.

Bat Population Information and Effects Analysis

WS occasionally receives requests for assistance associated with bats in Mississippi. Those requests have been primarily associated with bats that have entered inside buildings or with bats that have been found in public areas where people may encounter bats. Of the 14 native bat species found in Mississippi, WS anticipates receiving requests for assistance associated with the southeastern myotis, Brazilian free-tailed bat, silver-haired bat, big brown bat, evening bat, and Rafinesque's big-eared bat. Those bat species may occur in residences, buildings, and other human-created structures. WS has previously addressed requests for assistance associated with bats by providing recommendations through technical assistance and on occasion, through direct operational assistance.

WS infrequently receives requests for assistance associated with bats in Mississippi. From FY 2019 through FY 2023, WS captured two bats by hand inside residences and buildings and released those bats. In most cases, a single bat found in a building would be provided an escape route (*e.g.*, opening a door or window) or would be live captured and released outside on site if there was no possibility of an exposure to people or pets. If the bat appeared sick, acted unusually, or if there was a known bite or possible exposure to people or pets, the bat would be euthanized and submitted for rabies testing. Those bats euthanized by WS for disease testing would likely be euthanized and submitted for testing by other entities in the absence of WS' involvement given the risk to human safety associated with exposure. Therefore, lethal removal by WS for disease testing would not be additive to removal that would likely occur in the absence of involvement by WS.

No lethal removal of bats occurred by WS in Mississippi from FY 2019 through FY 2023 and WS does not anticipate using lethal methods to address damage or threats of damage associated with bats, unless human/pet exposure has occurred or WS' personnel or the entity requesting assistance suspects human/pet exposure. In those cases, an individual bat would likely be live-captured and euthanized for testing because bats are known to carry rabies. Based on previous requests for assistance received by WS and in those cases where exposure may require a bat be tested, WS does not anticipate live capturing and euthanizing more than five bats total annually.

When considering the use and/or recommendation of exclusionary methods and structural repairs, WS would also consider the potential for maternal colonies to be present in buildings and other structures to ensure those damage management activities employed or recommended would not result in the abandonment of young if adults were excluded from returning to maternal colonies. Bats typically give birth from May through July and weaning occurs in July and August. Young bats grow rapidly and can generally fly within three weeks (Greenhall Frantz 1994). When addressing roosting colonies inside buildings, WS would attempt to survey the roosting colony for the presence of young. If young were present or if observance of the roosting colony was not possible, WS would not conduct direct operational assistance from May through August. Similarly, property owners requesting technical assistance would also be advised about the possibility of a maternal colony being present from May through August. Recommendations would be for property owners to conduct structural repairs and exclusion activities during those months when young would be able to exit the structure or would not be present.

In those cases where human/pet exposure occurred or where WS' personnel or the entity requesting assistance suspect human/pet exposure, those bats euthanized by WS for disease testing would likely be euthanized and submitted for testing by other entities in the absence of WS' involvement given the risk to human safety associated with exposure. Therefore, the lethal removal of target bat species by WS would not be additive to removal that would likely occur in the absence of involvement by WS. The lethal removal of up to five individuals from a single species is unlikely. Most incidents involving exposure or suspected exposure involve a single bat that has entered inside the living space of a residence. Therefore, the lethal removal of five bats from a single colony is unlikely.

No threatened or endangered species have been encountered by WS during previous activities to alleviate damage or threats associated with bats. If the need arises, WS would consult with a qualified biologist to positively identify bats prior to removing them in order to eliminate any chance of addressing a T&E species.

On occasion, WS could be requested to retrieve a dead bat for disease testing. In those cases, WS' activities would not result in additional mortality because WS would only retrieve the carcass of the bat and WS' activities would not have resulted in the lethal removal of the bat; therefore, the environmental status quo would remain unchanged by WS' retrieval of the bat.

Several bat species are being adversely affected by the fungal disease known as white-nose syndrome, an emerging disease that is causing unprecedented morbidity and mortality among bats in eastern North America. This disease is caused by the fungus *Pseudogymnoascus destructans*, and has caused the death of millions of bats in the Eastern United States and Canada. This fungus grows in relatively cold conditions with high humidity, which makes many caves, abandoned mines, and other underground structures optimal growing sites for the disease during winter (Perry 2014).

WS' limited lethal removal of bats would not adversely affect overall populations of bat species in the state because any bat removal would be localized and limited in scope. In addition, euthanizing and submitting bats for testing would likely occur in the absence of WS' participation due to the risks to human safety.

Rabbit Population Information and Effects Analysis

There are nine species of cottontail rabbits in North America, north of Mexico. The eastern cottontail is the most abundant and widespread of all those species while the swamp rabbit is generally the largest member of the cottontail genus (Chapman and Litvaitis 2003). The eastern cottontail and the swamp rabbit are both present in Mississippi (Chapman and Litvaitis 2003). Both eastern cottontails and swamp rabbits occur statewide and occur in a wide variety of disturbed, early successional or shrub-dominated habitats (Chapman and Litvaitis 2003).

Cottontails do not distribute themselves evenly across the landscape but tend to concentrate in favorable habitats such as brushy fence rows or field edges, gullies filled with debris, brush piles, areas of dense briars, or landscaped backyards where food and cover are suitable. Cottontails rarely occur in dense forest or open grasslands, but fallow crop fields may provide suitable habitat. Within these habitats, they spend their entire lives in an area of 10 acres or less. Occasionally they may move a mile or so from summer range to winter cover or to a new food supply. In suburban areas, cottontails are numerous and mobile enough to fill any "*empty*" habitat created when other rabbits are removed. Population densities vary with habitat quality, but one rabbit per 0.4 hectares (1 acre) is a reasonable average (Craven 1994). They can raise as many as eight litters per year of one to 12 young (usually three to six), having a mean gestation period of only 28 days (Chapman and Litvaitis 2003).

As their name implies, swamp rabbits are never far from water and are primarily associated with wooded wetlands and canopy gaps in bottomland forests (Chapman and Litvaitis 2003). Terrel (1972) found the home ranges of swamp rabbits never extended more than 2 kilometers from a major body of water. Swamp rabbits have a similar appearance to cottontails but are generally larger and often lack the distinct rusty patch of fur on the upper neck that is generally present on the fur of cottontails.

No population estimates are available for cottontails and swamp rabbits in Mississippi. Information on population densities of cottontails and swamp rabbits is also unavailable. People can harvest cottontails and swamp rabbits in the state during statewide hunting seasons. The number of cottontails and swamp rabbits that people can harvest per day is limited to eight in any species combination (combined species total cannot exceed eight). However, the MDWFP allows a person to harvest an unlimited number of cottontails and swamp rabbits throughout the duration of the season. From the 2019-2020 hunting season through the 2022-2023 hunting season, hunters harvested an average of 192,096 cottontails and swamp rabbits. The highest harvest level occurred during the 2022-2023 season when people harvested 215,872 cottontails and rabbits in the state. Harvest data combines the two rabbit species (eastern cottontail and swamp rabbit). Harvest totals that only represent eastern cottontails or swamp rabbits are not currently available.

From FY 2019 through FY 2023, WS has lethally removed an average of six cottontails and 10 swamp rabbits per year using a firearm to alleviate damage and threats of damage in the state. In addition, WS dispersed one swamp rabbit from FY 2019 through 2023 to alleviate damage or threats of damage in the state. Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 50 cottontails and up to 50 swamp rabbits annually to alleviate damage and threats of damage, primarily at airports where rabbits may act as attractants for other wildlife that could pose aircraft strike hazards.

Based on the average number of cottontails and swamp rabbits harvested, WS' lethal removal of up to 50 cottontails and 50 swamp rabbits (100 take by WS) would represent 0.05% of the annual cottontail and swamp rabbit harvest. The lowest harvest level occurred during the 2021-2022 season when people harvested 160,264 cottontails and swamp rabbits in the state. If WS had lethally removed 50 cottontails and 50 swamp rabbits (100 take by WS) during FY 2021, the removal would have represented 0.06% of the lowest harvest level during 2021-2022 hunting season. Studies show that even if hunters harvest as many as 40% of the rabbits available in autumn, the rabbit population the following year would not decline because of the tremendous reproductive potential of rabbits (Fergus 2006). Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of cottontail and swamp rabbits annually would have no effect on the ability of those persons interested to harvest eastern cottontail and swamp rabbits during the regulated harvest season.

Black Bear Population Information and Effects Analysis

There are two subspecies of black bears that are currently known to occur in Mississippi. The American black bear (*U. a. americanus*) historically occurred throughout much of eastern North America, the Great Plains, and Canada, including the northern portion of Mississippi. The Louisiana black bear (*U. a. luteolus*) historically occurred in eastern Texas, Louisiana, southern Arkansas, and the southern portion of Mississippi. Harvest and habitat loss nearly eliminated the black bear from Mississippi by the 1900s with very isolated and small populations occurring in a few counties of the Delta region through the early-1920s (Young 2006, Simek et al. 2012). When hunting of black bears in the state was prohibited in 1932, fewer than 12 bears were thought to be present in the state, which lead to the black bear being included on the first rare and threatened list compiled in the state during 1975 (Young 2006, Simek et al. 2012). Black bears were further classified as endangered in the state when the endangered list was published for the state in 1984 (Young 2006, Simek et al. 2012).

The Louisiana black bear was formally listed as threatened in 1992 under the Endangered Species Act by the USFWS within the historic range of the subspecies. In addition, the USFWS listed other black bear subspecies within the historic range of the Louisiana black bear due to the similarities in appearance, including the American black bear. In 2016, the USFWS removed the Louisiana black bear from the federal list of endangered and threatened wildlife due to recovery and removed the similarity of appearance protections for the American black bear. The State of Mississippi continues to classify the black bear and the Louisiana black bear as state endangered (see Appendix F).

Although the statewide population of black bears is unknown and likely fluctuates based on time of year, food availability, and changing habitat, the population has been estimated at approximately 50 bears with populations likely increasing in the state (Young 2006, Simek et al. 2012). Until recently, the majority of the black bears found in the state were thought to be males dispersing from populations outside the state; however, more female bears are being located in the state (Young 2006, Simek et al. 2012). In addition, more female bears with cubs are being located within the state. During surveys conducted in 2011, females with newborn cubs were documented in Bolivar County along the Mississippi River, as well as litters in Sharkey, Issaquena, and Warren Counties in the south Delta Region (Young 2011).

Female black bears reach reproductive maturity at 3 to 4 years (Pelton 2003). Following a 7- to 8-month gestation period, they may have one to five cubs (Rogers 1976, Alt 1981, Kolenosky and Strathearn 1987). Juvenile black bear annual mortality ranges between 20 and 70%, with orphaned cubs having the highest mortality (Kolenosky and Strathearn 1987). Natural mortality in adult black bears is approximately 10 to 20% (Fraser et al. 1982).

At the request of the MDWFP or federal partners, WS could provide technical assistance and/or limited direct operational assistance to assist with managing damage associated with black bears in the state. Direct operational assistance would be limited to WS using culvert traps or foot snares to live-capture bears or could include providing/loaning electric fence to property owners or managers. In addition, WS could receive requests to participate in aversion techniques once bears were released. If requested by the MDWFP, WS could participate in the limited lethal removal of black bears. Lethal removal would only occur at the request of the MDWFP and would occur in limited situations where the MDWFP determines the black bear must be lethally removed. Any intentional lethal removal would occur pursuant to the appropriate permits or authorization for the lethal removal of black bears in the state. WS has not addressed black bears in Mississippi previously and anticipates WS participation with addressing black bears in the state to be limited to isolated situations when requested by the MDWFP or federal partners.

Raccoon Population Information and Effects Analysis

The raccoon occurs throughout most of the United States, with the exception of the higher elevations of mountainous regions and some areas of the arid southwest (Boggess 1994, Gehrt 2003). Raccoons are more common in the wooded eastern portions of the United States than in the more arid western plains (Boggess 1994) and are frequently found in cities or suburbs as well as rural areas (Gehrt 2003).

Absolute raccoon population densities are difficult or impossible to determine because of the difficulty in knowing what percentage of the population has been counted or estimated. In addition, it can be difficult to determine how large an area the raccoons are using (Sanderson 1987). Due to their adaptability, raccoon densities reach higher levels in urban areas than that of rural areas. Relative raccoon population densities have been variously inferred by removal of animals per unit area. For instance, Twichell and Dill (1949) reported removing 100 raccoons from tree dens in a 41 hectares (101 acres) waterfowl refuge area, while Yeager and Rennels (1943) studied raccoons on 881 hectares (2,177 acres) in Illinois and reported trapping 35 to 40 raccoons in 1938-39, 170 in 1939-1940, and 60 in 1940-1941. Slate (1980) estimated one raccoon per 7.8 hectares (19.3 acres) in New Jersey in predominantly agricultural land on the inner coastal plain. Raccoon densities of 100 per square mile (1 raccoon per 6.4 acres) have been attained around abundant food sources (Kern 2002). Riley et al. (1998) summarized rural raccoon densities based on published literature that ranged from 2 to 650 per square mile in rural habitats, with an average of 10 to 80 raccoons per square mile.

Raccoons occur statewide in Mississippi and thrive in a variety of habitats including rural, suburban, and urban areas (Gehrt 2003). However, the statewide population of raccoons is currently unknown. Using the average number of raccoons per square mile of 10 to 80 raccoons in rural areas provided by Riley et al. (1998), the estimated statewide population would be 469,000 to 3.8 million raccoons.

The State of Mississippi classifies raccoons as furbearers with regulated annual hunting and trapping seasons managed by the MDWFP. Currently, the MDWFP allows hunters and trappers to harvest an unlimited number of raccoons during the length of those seasons, although daily limits may apply during the annual hunting seasons. From the 2019-2020 hunting/trapping season through 2022-2023 hunting/trapping season, hunters and trappers harvested an average of 142,190 raccoons per year in Mississippi. As with other furbearing species, people can lethally remove raccoons to alleviate damage or threats of damage when authorized by the MDWFP. The total number of raccoons lethally removed annually in the state to alleviate damage or threats of damage is currently unknown.

From FY 2019 through FY 2023, WS lethally removed an average 18 raccoons per year in Mississippi, which includes the intentional and unintentional lethal removal of raccoons by WS. The unintentional lethal removal of raccoons by WS occurs during activities targeting other wildlife species, primarily during activities targeting aquatic rodents. In addition, WS live captured and released an average of two raccoons per year in Mississippi from FY 2019 through FY 2020, which includes the intentional and unintentional capture of raccoons by WS.

Based on previous requests for assistance received by WS to alleviate damage and in anticipation of receiving additional requests for assistance with managing damage, WS could lethally remove up to 150 raccoons annually in Mississippi under all wildlife damage management activities, including unintentional removal during other wildlife damage management activities. The lethal removal of 150 raccoons in Mississippi per year by WS would represent 0.1% of the average number of raccoons harvested by hunters and trappers per year in Mississippi, which was estimated at 142,190 raccoons.

Using the lowest population estimate of 469,000 raccoons in the state, the lethal removal of 150 raccoons would represent 0.03% of the population. People have harvested approximately

142,190 raccoons per year from the 2019-2020 hunting/trapping season through 2022-2023 hunting/trapping season. If the average number of raccoons harvested annually were representative of future harvest levels, the removal of raccoons (*i.e.*, WS' removal of 150 raccoons and the harvest of 142,190 raccoons annually) would represent 30.4% of a statewide population estimated at 469,000 raccoons. If the statewide population of raccoons was 3.8 million, the number of racoons removed would represent 3.8% of the statewide population.

Raccoon populations can remain relatively abundant if annual harvest levels are below 49% (Sanderson 1987). In addition, the statewide population is likely more than 1.9 million raccoons. As with many of the other mammal species harvested in the state, the unlimited harvest levels allowed by the MDWFP during the length of the hunting and trapping seasons provides an indication that lethal removal, including removal for damage management, would not reach a level where overharvest of the raccoon population would occur. The MDWFP has regulatory authority over the management of wildlife within the state, including raccoons, and all removal by WS has occurred and would continue to occur only after the MDWFP authorized the removal and WS' removal would only occur at levels the MDWFP authorized. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of raccoons annually would have no effect on the ability of those persons interested to harvest raccoons during the regulated harvest season.

River Otter Population Information and Effects Analysis

Historically, river otters inhabited a variety of aquatic ecosystems throughout much of North America, excluding the frozen Arctic and arid Southwest (Melquist et al. 2003). Human encroachment, habitat destruction, and overharvest have eliminated river otters from marginal portions of their range. However, present distribution spans the North American continent from east to west and extends from southern Florida to northern Alaska (Melquist and Dronkert 1987, Melquist et al. 2003).

River otters remained relatively abundant in Mississippi despite declines in other parts of the country. River otters are known to occur throughout Mississippi where appropriate aquatic habitat exists. The number of river otters present in Mississippi is currently unknown. Melquist and Dronkert (1987) summarized studies estimating river otter densities, which showed that densities were about 1 per 175 to 262 acres in Texas coastal marshes and ranged from 1 per 1.8 miles to 1 per 3.6 miles of waterway (stream or river), which is an average of 1 otter per 2.4 miles of waterway. Shirley et al. (1988) found 1 river otter per 213 acres of coastal marshland in Louisiana. Density information for river otters specific to Mississippi is not currently available. To provide an indication of the potential magnitude of lethal removal that could occur by WS, this analysis will use the available otter densities to estimate a statewide otter population.

There are over 2.7 million acres of freshwater wetlands and 52,875 acres of tidal wetlands in Mississippi along with approximately 82,000 miles of rivers and streams in the state (Mississippi Department of Environmental Quality 2022). Of the 82,000 miles of streams and rivers in the state, 26,379 miles are considered perennial river miles where water is present throughout the year. Using only those river miles with water throughout the year, the number of river otters inhabiting streams and rivers in the state could range from 7,300 to 14,700 river otters in

Mississippi. If river otter densities in coastal marshes is similar to freshwater wetlands, the number of river otters that inhabit freshwater wetlands could range from 10,300 to 15,400 river otters in Mississippi. Therefore, the statewide population could range from 17,600 to 30,100 river otters.

River otters are a state-regulated furbearer in Mississippi with an annual trapping season. During the trapping season, people can harvest an unlimited number of river otters. From the 2019-2020 through the 2022-2023 trapping season, people harvested an average of 1,669 river otters annually in Mississippi.

WS could also receive requests for assistance to manage damage caused by river otters in the state and could lethally remove river otters unintentionally during activities targeting other wildlife species, primarily aquatic rodents. Based on previous activities conducted by WS and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 120 river otters annually in the state, including unintentional lethal removal that could occur during other damage management activities.

If the lowest derived population estimate were reflective of the actual statewide population of river otters in the state, removal of up to 120 river otters by WS would represent 0.7% of the population estimated at 17,600 river otters. The annual take of 120 river otters by WS would represent 7.2% of the average number of river otters that people harvested in the state per year from the 2019-2020 trapping season through the 2022-2023 trapping season, which was estimated to be 1,669 river otters. The combined removal by WS and trappers in the state represented 10.2% of a statewide population estimated at 17,600 river otters and 5.9% of a statewide population estimated at 30,100 river otters.

As with many of the mammal species addressed in this document, the unlimited removal allowed by the MDWFP provides an indication that harvest during the regulated trapping season and removal for damage management, is not likely to reach a level where overharvest would occur. River otters maintain sufficient densities in the state to allow annual harvesting, which the MDWFP regulates, including removal that occurs during damage management activities. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of otters annually would have no effect on the ability of those persons interested to harvest otters during the regulated harvest season.

Striped Skunk Population Information and Effects Analysis

Striped skunks occur throughout most of North American from the southern half of Canada to northern Mexico (Rosatte and Lariviere 2003). According to Chamberlain and Leopold (2001), very little information regarding striped skunk densities in the southeast exists other than those based on harvest numbers and trapper/hunter observations. Skunk densities vary widely according to habitat, season, food sources, geographic location, and mortality rates. Densities have ranged from a low of 1.3 to 6.2 striped skunks per square mile in the parklands of central Alberta, Canada to highs of 33 to 67 striped skunks per square mile in an area of Illinois and 98 striped skunks per square mile in fields near commercial sites in Toronto, Canada (Rosatte 1987, Rosatte and Lariviere 2003).

A density estimate and population estimate for striped skunks in Mississippi are currently not available. With the State of Mississippi encompassing nearly 46,924 square miles, the statewide population could range from 61,000 to nearly 4.6 million striped skunks. The State of Mississippi classifies striped skunks as "*nuisance animals*" (see Mississippi Code Annotated 49-7-1), which allows people to lethally remove skunks throughout the year on private property with no limit on the number that people can remove. In addition, people can trap skunks during an annual season that places no limit on the number of skunks that people can harvest daily and no limit on the number of skunks that people can possess throughout the trapping season. From the 2019-2020 trapping season through the 2022-2023 season, people trapped an average of 605 striped skunk per year in the state. Other entities besides WS also likely lethally remove skunks to alleviate damage or threats of damage; however, the number of skunks lethally removed annually in the state to alleviate damage or threats of damage is currently unknown.

From FY 2019 through FY 2023, WS has lethally removed an average of nine striped skunks per year in Mississippi, primarily using firearms. Based on previous requests for assistance received by WS to alleviate damage and in anticipation of receiving additional requests for assistance with managing damage, WS could lethally remove up to 50 striped skunks annually in Mississippi, which would includes striped skunks lethally removed unintentionally during other wildlife damage management activities.

Using the lowest population estimate of 61,000 striped skunks, the take of 50 skunks would represent 0.08% of the estimated statewide population. People have harvested an average of 605 striped skunks per year in the state from the 2019-2020 trapping season to the 2022-2023 season. The highest harvest level occurred during 2021-2022 harvest season when people reported harvesting 794 striped skunks. If WS had lethally removed 50 striped skunks during the 2021-2022 harvest season, the numberremoved would have represented 1.4% of the statewide population estimated at 61,000 striped skunks. Combining the average annual harvest of 605 striped skunks in the state with WS' potential removal of 50 striped skunks annually, the number skunks removed would represent 1.1% of the lowest population estimate in the state.

The classification of striped skunks as a "nuisance species" and the unlimited removal allowed by the MDWFP provides an indication that harvest during the regulated trapping season and removal for damage management, is not likely to reach a level where lethal removal would result in adverse effects to their population.

Coyote Population Information and Effects Analysis

Many references indicate that coyotes originally occurred in relatively open habitats, particularly grasslands and sparsely wooded areas of the western United States. The distribution of coyotes in eastern North America began to expand from 1900 to 1920. Now, all eastern states and Canadian provinces have at least a small population of coyotes (Voigt and Berg 1987, Tischaefer 2020). Today, coyotes occur throughout most of North America, including the United States. Coyotes have adapted to, and now exist in virtually every type of habitat, arctic to tropic, in North America. Coyotes live in deserts, swamps, tundra, grasslands, brush, dense forests, from below sea level to high mountain ranges, and at all intermediate altitudes. High densities of coyotes also appear in the suburbs of major cities (Green et al. 1994).

Similar to striped skunks, the MDWFP has classified coyotes as "*nuisance animals*" that people can lethally remove throughout the year with no limit on the number that people can remove. In addition, people can harvest coyotes during the annual trapping season. From the 2019-2020 through the 2022-2023 hunting and trapping seasons, people harvested an average of 68,485 coyotes in Mississippi. The number of coyotes that people lethally remove to alleviate damage or threats of damage in the state is unknown.

From FY 2019 through FY 2023, WS lethally removed an average of 14 coyotes per year in the state to alleviate damage or threats of damage. The highest annual take by WS occurred in FY 2023 when WS lethally removed 35 coyotes. WS lethally removed coyotes using firearms and cable devices. In addition, WS used foothold traps to live-capture coyotes that were then euthanized using firearms. WS also dispersed coyotes to alleviate damage or threats of damage from FY 2019 through FY 2023. WS dispersed coyotes using vehicle presence and the noise associated with the use of a firearm.

Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 100 coyotes annually in the state if WS implemented Alternative 1, which would include the unintentional take of coyotes during activities targeting other animals. As stated previously, people in the state harvested an average of 68,485 coyotes per year from the 2019-2020 through the 2022-2023 hunting and trapping season. The take of up to 100 coyotes by WS would represent 0.2% of the average number of coyotes harvested each year by hunters in the state.

Coyotes are highly mobile animals with home ranges (territories) that vary by sex and age of the animal, food abundance, habitat, and season of the year (Pyrah 1984, Bekoff and Gese 2003). Coyote populations are comprised of territorial and non-territorial individuals. Each territory contains a dominant pair, associated subordinates, and pups. Pre-whelping pack size ranges from two to 10 individuals (Gese et al. 1996, Knowlton et al. 1999). Coyotes breed between January and March and are able to breed prior to reaching one year of age (Kennelly and Johns 1976), but the percentage of yearlings having litters varies from zero to 80% in different populations (Gier 1968). This variation is influenced by a number of factors causing large annual variations in total number of coyotes breeding. In a Texas study, the percentage of females having litters varied from 48% to 81% (Knowlton 1972). Pups are born after a gestation period of 60 to 63 days, with litter sizes varying primarily with prey availability. Each dominant pair can produce a single litter of four to eight pups (Knowlton 1972, Gese et al. 1996). Gier (1968) reported average litter sizes of 4.8 to 5.1 in years with low rodent numbers, but litters of 5.8 to 6.2 during years with high rodent numbers.

The coyote is probably the most extensively studied carnivore (Bekoff and Gese 2003), and considerable research has been conducted on population dynamics. However, methods for estimating carnivore populations are crude and often produce estimates with broad confidence intervals (Crawford et al. 1993). Because determinations of absolute coyote densities are frequently unknown (Knowlton 1972), many researchers have estimated coyote populations using various methods (Clark 1972, Knowlton 1972, Camenzind 1978, Pyrah 1984, Knowlton et al. 1999). The cost to determine absolute coyote densities accurately over large areas is prohibitive (Connolly 1992) and the cost would not appear to be warranted given the coyote's overall relative abundance.

The presence of unusual food concentrations and the assistance provided to a breeding pair by non-breeding coyotes at the den can influence coyote densities and complicate efforts to estimate abundance (Danner and Smith 1980). Coyote densities are lowest in late winter prior to whelping, highest immediately after whelping, followed by a continued decline to the next whelping season (Parker 1995, Knowlton et al. 1999). Each occupied coyote territory may have several nonbreeding helpers at the den during whelping (Allen et al. 1987). Therefore, each defended coyote territory may have more than just a pair of coyotes. Messier and Barrette (1982) reported that from November through April, 35% of the coyotes were in groups of three to five animals and Gese et al. (1988) reported that coyote groups of 2, 3, 4, and 5 individuals comprised 40%, 37%, 10%, and 6% of the resident population, respectively.

Coyote densities can range from 0.5 coyotes per square mile to six coyotes per square mile (Voigt and Berg 1987, Knowlton et al. 1999, Bekoff and Gese 2003). Knowlton (1972) concluded that coyote densities might approach a high of five to six coyotes per square mile under extremely favorable conditions. Coyote densities can vary considerably between habitat types and vary based on numerous environmental variables. For example, Fedriani et al. (2001) studied three sites: one with low human impact, one with high human impact, and one with intermediate human impact. Fedriani et al. (2001) found the lowest coyote densities within the low human impact site (0.8-1.0 coyotes per square mile), and highest densities within the high human impact site (6.2-7.8 coyotes per square mile). The intermediate-human impact site had intermediate coyote density (4.1-5.2 coyotes per square mile). The high human impact site had some of the highest densities reported for coyotes, exceeded only by a study in suburban Arizona where human impacts were also high (McClure et al. 1996).

The unique resilience of the coyote, its ability to adapt, and its perseverance under adverse conditions is commonly recognized among biologists and land managers. Despite intensive historical damage management efforts in livestock production areas and despite sport hunting and trapping for fur, coyotes continue to thrive and expand their range, occurring widely across North and Central America (Connolly 1978, Miller 1995, Kays 2018). While removing animals from small areas at the appropriate time can protect vulnerable livestock, immigration of coyotes from the surrounding area can quickly replace the animals removed (Stoddart 1984, Windberg and Knowlton 1988). Compensatory reproduction and mortality factors also contribute to rapid population recovery after removals and the ability of coyote populations to sustain relatively high levels of removals over time.

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

Coyotes are present statewide in Mississippi and inhabit a variety of habitats. However, actual population estimates and density information for coyotes in Mississippi are not currently available. This analysis calculates a population estimate based upon the published densities of coyotes because population information is not available for coyotes in Mississippi. As stated previously, coyote densities can vary considerably between habitat types and vary based on numerous environmental variables. From available literature, coyote densities can range from 0.5 coyotes per square mile to six coyotes per square mile (Voigt and Berg 1987, Knowlton et al. 1999, Bekoff and Gese 2003). Therefore, a statewide population could range from 23,462 to 281,544 coyotes in Mississippi.

Based on the estimated harvest data for coyotes and the lack of any indication the coyote population in Mississippi is declining, the statewide population density likely exceeds 0.5 coyotes per square mile. The MDWFP continues to allow people to harvest coyotes during annual hunting and trapping seasons with no limit on the number of coyotes that people can harvest. In addition, the State of Mississippi continues to classify coyotes as "*nuisance animals*" that people can lethally remove at any time on private property. Therefore, there is no current evidence that harvest and damage management activities would reach a magnitude that would cause a coyote population decline in the state.

The International Union for Conservation of Nature and Natural Resources stated, "*Coyotes are abundant throughout their range and are increasing in distribution…*" and "*Localized control efforts have sometimes temporarily reduced population size, but they quickly rebound through migration and breeding, and Coyote populations generally are stable or increasing in most areas* [sic]" (Kays 2018).

Although exact population estimates for coyotes in Mississippi are not currently available, the unlimited harvest allowed by the MDWFP for the species and the continuous open hunting season indicates the species is not at risk of overharvesting. The magnitude of WS' activities to alleviate damage and threats associated with coyotes in the state would be low with the oversight and permitting of WS' activities occurring by the MDWFP. WS would annually report to the MDWFP and monitor removal to ensure WS' activities do not adversely affect the coyote population in the state.

Gray Fox Population Information and Effects Analysis

The gray fox is common in many parts of the United States where deciduous woodlands provide habitat (Fritzell 1987). They inhabit wooded, brushy, and rocky habitats from extreme southern Canada to northern Venezuela and Colombia, excluding portions of the mountainous northwestern United States, the Great Plains, and eastern Central America. Gray fox occur over most of North America, north and east from southern California, Arizona, and central Texas (Fritzell 1987). In eastern North America, gray fox are closely associated with edges of deciduous forest. They can also be found in urban areas where suitable habitat exists (Phillips and Schmidt 1994).

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

The State of Mississippi has classified the gray fox as a "*nuisance animal*" that people can lethally remove on private property throughout the year with no limit on the number that people can remove. People can also harvest gray fox during annual trapping seasons. During the annual trapping season, people can harvest an unlimited number of gray fox during the length of the season. People can also hunt gray fox in Mississippi on private property throughout the year. From the 2019-2020 through the 2022-2023 hunting and trapping seasons, people harvested an average of 4,016 gray fox per season in Mississippi. The number of gray fox that people lethally remove to alleviate damage or threats of damage in the state is unknown.

WS occasionally receives requests for assistance in Mississippi to manage damage or threats of damage associated with gray fox. From FY 2019 through FY 2023, WS only addressed gray fox during FY 2020. In FY 2020, WS live captured a gray fox in a foothold trap and subsequently euthanized the gray fox using a firearm. Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 50 gray fox annually in the state if WS implemented Alternative 1, which would include the unintentional take of gray fox during activities targeting other animals.

Gray fox occur statewide in Mississippi in areas with suitable habitat. If the density of gray fox in the state was 3.1 gray fox per square mile, the statewide population could be approximately 145,500 gray fox. With a population estimate of 145,500 gray fox, the lethal removal of 50 gray fox by WS would represent 0.03% of the population. If the average number of gray fox harvested annually were representative of future harvest levels, the removal of gray fox (*i.e.*, WS' removal of 50 gray fox and the harvest of 4,016 gray fox annually) would represent 2.8% of a statewide population estimated at 145,500 gray fox. From the 2019-2020 through the 2022-2023 hunting and trapping season, the highest annual harvest of gray fox in the state occurred in 2022-2023 when hunters and trappers harvested 6,434 gray fox. If WS lethally removed 50 gray fox and the annual harvest reached 6,434 gray fox, this would represent 4.5% of the estimated statewide population. Like other mammal species addressed in this EA, the unlimited removal allowed by the MDWFP during the harvest seasons and the permitting of lethal removal to alleviate damage by the MDWFP provides an indication that gray fox populations maintain sufficient densities within the state to sustain unlimited harvest and that overharvest is unlikely.

Red Fox Population Information and Effects Analysis

Red fox are found throughout most of the United States with the exception of a few isolated areas. Prehistoric fossil records suggest the red fox may not have inhabited much of the United States, but fox were plentiful in many parts of Canada. However, it has been suggested that climatic factors, interbreeding with the introduced European red fox, extirpation of the gray and red wolf, and clearing of land for agriculture has possibly contributed to the present-day expansion and range of red fox in North America (Voigt 1987).

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

Red fox can be found statewide in Mississippi in suitable habitat. If the density of red fox in Mississippi were 2.6 red fox per square mile, the statewide population could be estimated at nearly 122,000 red fox. The State of Mississippi has classified the red fox as a "*nuisance animal*" that people can lethally remove on private property throughout the year with no limit on the number that people can remove. People can also harvest red fox during annual trapping seasons. During the annual trapping season, people can harvest an unlimited number of red fox during the length of the season. People can also hunt red fox in Mississippi on private property throughout the year. From the 2019-2020 through the 2022-2023 hunting and trapping seasons, people harvested an average of 1,898 red fox per season in Mississippi. The number of red fox that people lethally remove to alleviate damage or threats of damage in the state is unknown.

WS occasionally receives requests for assistance in Mississippi to manage damage or threats of damage associated with red fox. From FY 2019 through FY 2023, WS only addressed red fox during FY 2022. In FY 2020, WS lethally removed one red fox using a firearm. Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 50 red fox annually in the state if WS implemented Alternative 1, which would include the unintentional take of red fox during activities targeting other animals.

Red fox occur statewide in Mississippi in areas with suitable habitat. If the density of red fox in the state was 2.6 red fox per square mile, the statewide population could be approximately 122,000 red fox. With a population estimate of 122,000 red fox, the lethal removal of 50 red fox by WS would represent 0.04% of the population. If the average number of red fox harvested annually were representative of future harvest levels, the removal of red fox (*i.e.*, WS' removal of 50 red fox and the harvest of 1,898 red fox annually) would represent 1.6% of a statewide population estimated at 122,000 red fox. From the 2019-2020 through the 2022-2023 hunting and trapping season, the highest annual harvest of red fox in the state occurred in 2022-2023 when hunters and trappers harvested 3,734 red fox. If WS lethally removed 50 red fox and the annual harvest reached 3,734 red fox, this would represent 3.1% of the estimated statewide population.

Although exact population estimates for red fox in Mississippi are not available, the unlimited harvest limits allowed by the MDWFP for the species during hunting and trapping seasons and the classification of the species as a "*nuisance animal*" indicates the species is not at risk of overharvesting. The proposed lethal removal of red fox would be a small component of the overall harvest of red fox in the state. The overall removal would be of low magnitude when compared to the actual statewide population and the number of fox harvested during the annual harvest seasons.

Bobcat Population Information and Effects Analysis

Bobcats range from southern Canada throughout most of the contiguous United States and into northern Mexico (Anderson and Lovallo 2003). Ruell et al. (2009) reported bobcat densities ranged from 0.65 to 1.09 bobcats per square mile (0.25 to 0.42 bobcats per square kilometer) in coastal southern California in both large open habitat and in habitat surrounded by human development. Lawhead (1984) reported bobcat densities of 0.66 per square mile (0.26 bobcats per square kilometer) in Arizona with a preference for riparian habitat. Bobcats in southern Illinois were reported to have a population density of 0.70 bobcats per square mile (0.27 bobcats per square kilometer) (Nielsen and Woolf 2001), while Anderson (1987) provided population density estimates of 0.13 to 0.26 bobcats per square mile (0.05 to 0.10 bobcats per kilometer). Bobcats reach densities of about one per 0.7 square kilometer (1 per ¼ square mile) on some islands in the Gulf Coast of the southeastern United States. Densities vary from about one per 1.3 square kilometer (1 per ½ square mile) in coastal plains to about 1 cat per 10.7 square kilometer (1 per 4 square miles) in portions of the Appalachian foothills. Mid-Atlantic and mid-western states usually have scarce populations of bobcats (Virchow and Hogeland 1994).

Rates of natural mortality reported for adult bobcats in protected populations appear to be quite low. Crowe (1975) estimated a 3% mortality rate in a protected population, based on study of bobcats in southeastern Idaho conducted by Bailey (1972). Causes of natural mortality for adult bobcats include starvation (Hamilton 1982), disease and predation (Lembeck 1978), and injuries inflicted by prey (Fuller et al. 1985).

Bobcats are present statewide in Mississippi and occur in a variety of habitats that can range from coniferous forests to mixed forests to grasslands to swamps. However, the statewide population of bobcats is unknown. The State of Mississippi classifies bobcats as "*fur-bearing animals*" (see Mississippi Code Annotated 49-7-1) and the MDWFP has established regulated annual hunting and trapping seasons for bobcats. During the annual trapping season, there is no daily or possession limit for bobcats. During the current annual hunting season, the MDWFP allows hunters to harvest up to five bobcats per day with a daily limit of eight per party;

however, there is no limit on the number of bobcats a person can possess during the length of the season. From the 2019-2020 through the 2022-2023 hunting and trapping seasons, people harvested an average of 7,880 bobcats per season in Mississippi. The number of bobcats that people lethally remove to alleviate damage or threats of damage in the state is unknown.

From FY 2019 through FY 2023, WS lethally removed one bobcat in FY 2020 using a firearm and one bobcat in FY 2022 that WS captured in a foothold trap and subsequently euthanized. Based upon an anticipated increase in damage management activities associated with bobcats in the future, it is possible that WS could kill up to 50 bobcats per year in Mississippi, including bobcats that WS could unintentionally lethally remove during activities targeting other animals. The lethal removal of up to 50 bobcats per year by WS would represent 0.6% of the average number of bobcats that people harvested in the state from the 2019-2020 through the 2022-2023 hunting and trapping seasons.

The statewide bobcat population is currently unknown and density information for Mississippi is currently not available. In a survey of state wildlife management agencies, Roberts and Crimmins (2010) reported the statewide population at 52,436 bobcats with an increasing population trend. If the average number of bobcats harvested annually by hunters and trappers were representative of future harvest levels, the cumulative removal of bobcats (*i.e.*, WS' removal of 50 bobcats and the harvest of 7,880 bobcats annually) would represent 15.1% of a statewide population estimated at 52,436 bobcats. From the 2019-2020 through the 2022-2023 hunting and trapping seasons, the highest annual harvest of bobcats in the state occurred during the 2021-2022 season when people harvested 9,011 bobcats. If WS lethally removed 50 bobcats and the annual harvest reached 9,011 bobcats, the cumulative removal would represent 17.3% of a statewide population estimated at 52,436 bobcats.

Like other mammal species addressed in this EA, the unlimited harvest allowed by the MDWFP during the hunting and trapping seasons provides an indication that bobcat populations maintain sufficient densities within the state to sustain unlimited harvest and that overharvest is unlikely. The lethal removal of bobcats by WS would only occur when authorized by the MDWFP and only at levels authorized. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of bobcats annually would have no effect on the ability of those persons interested to harvest bobcats during the regulated harvest season.

Feral Swine Population Information and Effects Analysis

Feral swine are not native to North America, including Mississippi. Given adequate nutrition, a wild pig population can double in just four months. Feral swine may begin to breed before six months of age and sows can produce two litters per year (Barrett and Birmingham 1994). In Mississippi, feral swine occur statewide and often exploit a variety of habitats. The State of Mississippi considers feral swine to be a "*nuisance animal*", which allows people to lethally remove feral swine throughout the year on private property. From the 2019-2020 through the 2022-2023 hunting seasons, people harvested an average of 300,855 feral swine per season in Mississippi. From FY 2019 through FY 2023, WS lethally removed an average of 4,228 feral swine in Mississippi to alleviate damage.

The number of feral swine present in Mississippi is unknown. Timmons et al. (2012) was able to model population growth rates for the feral swine population in Texas using demographic parameters gathered from feral swine in the southeastern United States. Using those demographic parameters, Timmons et al. (2012) estimated an average annual growth rate of 21% for feral swine populations in Texas. If the average annual harvest of feral swine in Texas represented 28% of the population, Timmons et al. (2012) expected the statewide population to double every five years. If annual harvest rates reached 41% of the statewide population, Timmons et al. (2012) predicted the population would continue to increase at a rate of 12% per year. The model determined that an annual harvest of 66% of the population was needed to hold the population stable (Timmons et al. 2012). In another example, the South Carolina Wild Hog Task Force (2012) estimated that 50 to 75% of the statewide feral swine population in South Carolina would have to be removed annually to stabilize or reduce the population in that state.

Based on previous requests for assistance and the likelihood of increased funding to manage the feral swine population, WS could lethally remove up to 25,000 feral swine annually in the state to alleviate damage associated with requests for assistance and for disease surveillance. However, the annual removal of feral swine by WS could exceed 25,000 feral swine if populations continue to increase, if additional funding was provided to manage feral swine damage, and the number of requests for assistance continued to increase. Feral swine are not native to Mississippi; therefore, maintaining a local and/or statewide population at the lowest level, including extirpation, could be the goal of the MDWFP and to achieve those goals of lowering the statewide population, the annual removal by WS could exceed 25,000 feral swine. Damage management activities associated with feral swine would target single animals or local populations of feral swine at sites where their presence was causing unacceptable damage or threats to agriculture, human health and safety, natural resources, or property.

Activities conducted by WS under the proposed action alternative would occur within the goals and strategies outlined for the statewide feral swine population by the MDWFP. Maintaining a local and/or statewide feral swine population at the lowest level possible could be the goal of the MDWFP. Feral swine are not native to North America, including Mississippi. The National Invasive Species Council specifically lists feral swine as an invasive species pursuant to Executive Order 13112. Executive Order 13112 and Executive Order 13751 directs federal agencies to address invasive species to the extent practicable and permitted by law. WS Directive 2.320 provides guidelines for WS' actions in the management of invasive species in fulfillment of Executive Order 13112. In addition, Lowe et al. (2000) ranked feral swine as one of the 100 worst invasive species in the world.

White-tailed Deer Population Information and Effects Analysis

White-tailed deer have a wide distribution in North America (Miller et al. 2003) and some people have suggested that white-tailed deer currently occupy the largest geographic range of any other land mammal in North America (Pagel et al. 1991). Rural areas containing a matrix of forest and agricultural crops can contain the highest deer densities (Roseberry and Woolf 1998). White-tailed deer occur in areas with adequate woodlands interspersed with early-successional habitats (Miller et al. 2003). White-tailed deer are highly adaptable and live in many habitats, including woodlots in rural areas, the suburbs, and deep within heavily forested areas. The statewide white-tailed deer population may range from 1.5 to 1.75 million white-tailed deer in Mississippi (Deer Friendly 2024, Mississippi State University Extension 2024).

The State of Mississippi classifies white-tailed deer as a game species in the state, which are managed by the MDWFP. The MDWFP allows people to harvest white-tailed deer during annual hunting seasons. From the 2019-2020 through the 2022-2023 hunting seasons, people harvested an average of 258,313 white-tailed deer per season in Mississippi. The highest annual harvest of white-tailed deer from the 2019-2020 through the 2022-2023 hunting seasons occurred during the 2021-2022 season when people harvested 273,532 white-tailed deer in Mississippi.

From FY 2019 through 2023, WS used lethal methods to remove an average of 50 white-tailed deer per year in Mississippi with the highest level of removal occurring in FY 2019 when WS' personnel lethally removed 83 white-tailed deer. WS lethally removed white-tailed deer using firearms. All lethal removal by WS occurred after receiving a request for assistance with resolving damage caused by white-tailed deer. In addition, WS' personnel employed non-lethal methods to disperse an average of 49 white-tailed deer per year from FY 2019 through FY 2023. WS dispersed white-tailed deer using pyrotechnics, presence of vehicles, and the noise produced from using a firearm.

Based on a review of previous requests for assistance and in anticipation of an increasing number of requests for assistance, WS anticipates that future lethal removal would not exceed 700 white-tailed deer annually, which could include requests from the MDWFP and/or the MDAC to assist with sampling and managing the spread of diseases found in free-ranging and/or captive white-tailed deer populations. The MDWFP must authorize and permit any lethal removal of white-tailed deer in the state, including any removing occurring by WS.

If requested, WS could also assist with sampling and removing white-tailed deer from captive facilities where deer are confined inside a perimeter fence. The detection of a disease at a captive facility often raises concerns of the potential spread of diseases to free-ranging herds. The spread of diseases among deer inside those facilities is often increased due to their close contact with one another. Often, once a disease is detected in a confined deer herd, the entire herd is destroyed to ensure the containment of the disease. Any involvement with the depopulation of white-tailed deer confined inside a perimeter fence by WS would be at the request of the MDWFP and/or the MDAC. White-tailed deer confined inside perimeter fences for the purposes of non-traditional farming, including confined for hunting, are not included in statewide deer population management objectives. However, because lethal removal of white-tailed deer by WS for disease surveillance or monitoring could occur in free-ranging or captive herds, the potential lethal removal of white-tailed deer for disease surveillance and monitoring by WS would be part of the impact analysis on the statewide free-ranging deer population. Therefore, the analyses will evaluate the lethal removal of up to 700 white-tailed deer annually by WS at the request of cooperators and approved by the MDWFP, including white-tailed that WS could lethally remove as part of disease monitoring and surveillance.

In addition to WS' intentional removal of white-tailed deer to resolve or prevent damage, WS also conducts other damage management activities that pose a risk of lethally removing white-tailed deer unintentionally. From FY 2019 through FY 2023, WS' personnel did not lethally remove white-tailed deer unintentionally. However, the unintentional removal of white-tailed deer could occur during other damage management activities. Based on the limited unintentional removal that occurred from FY 2019 through FY 2023 during other program activities in Mississippi and after the review of proposed activities, the unintentional removal of white-tailed deer by WS during other activities is not likely to increase to any appreciable extent. The unintentional removal of white-tailed deer by WS would continue to be minimal.

If removal by WS reached 700 white-tailed deer annually, WS' removal would have represented 0.3% of the average number of white-tailed deer that people harvested in the state from the 2019-2020 through the 2022-2023 hunting seasons. If the average number of white-tailed deer harvested annually were representative of future harvest levels, the cumulative removal of white-tailed deer (*i.e.*, WS' removal of 700 white-tailed deer and the harvest of 258,313 white-tailed deer annually) would represent 17.3% of a statewide population estimated at 1.5 million white-tailed deer. Using the highest annual harvest of white-tailed deer from the 2019-2020 through the 2022-2023 hunting seasons, the cumulative lethal removal of white-tailed deer (*i.e.*, WS' removal of 700 white-tailed deer and the harvest of 273,532 white-tailed deer annually) would represent 18.3% of a statewide population estimated at 1.5 million white-tailed deer.

The EPA approved the use of GonaCon™ 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 the reproductive inhibitor. Additionally, in order for WS or a wildlife management agency to use GonaCon™ in any given state, the appropriate state agency responsible for managing wildlife must also approve the use of the product along with the appropriate state agency responsible for registering pesticides. The reproductive inhibitor GonaCon™ is currently not registered for use in Mississippi. However, if GonaCon™ becomes available to manage deer in the state, WS could consider the use of the reproductive inhibitor under the proposed action. GonaCon™ would be a method that WS could consider as part of an integrated methods approach to managing damage.

Population management from the use of reproductive inhibitors to induce a decline in a localized deer population occurs through a reduction in the recruitment of fawns into the population by limiting reproductive output of adults. A reduction in the population occurs when the number of deer being recruited into the population cannot replace those individuals that die from other causes each year, which equates to a net loss in the number of individuals in the population and a reduction in the overall population. Although not generally considered a lethal method because no direct removal occurs, reproductive inhibitors can result in the reduction of a target species' population. WS' use of GonaCon™ would target a local deer population identified as causing damage or threatening human safety. Although a reduction in a local deer population would likely occur from constant use of GonaCon™, the actual reduction in the local population annually would be difficult to derive prior to the initiation of the use of the vaccine.

One of the difficulties in calculating and analyzing any actual reduction that could occur from the use of the vaccine in a targeted population prior to application of the vaccine is the variability in the response of deer to the vaccine. Previous studies on GonaCon™ as a reproductive inhibitor have shown variability in the immune response of deer to the vaccine (Miller et al. 2000). Not all deer injected with GonaCon™ develop sufficient antibodies to neutralize the Gonadotropin-releasing Hormone (GnRH) produced in the body. Those white-tailed deer continue to enter into a reproductive state and produce fawns even after vaccination. The number of white-tailed deer that do not develop sufficient antibodies after the initial vaccination cannot be predicted beforehand. In one study, 88% of the deer vaccinated with GonaCon™ did not produce fawns the following reproductive season while 12% of the deer injected with GonaCon™ produced fawns (Gionfriddo et al. 2009). The year following the initial vaccination, the number of deer that were vaccinated the first year that did not produce fawns declined to 47% while the number of deer producing fawns increased to 53% (Gionfriddo et al. 2009) demonstrating the diminishing results that are likely over time if deer are not provided a booster shot periodically.

Because the effects of GonaCon™ are generally reversible if white-tailed deer do not receive a booster shot periodically, the reduction in a local population of deer from the use of GonaCon™ could be maintained at appropriate levels where damages or threats were resolved by increasing or decreasing the number of deer receiving booster injections. Although localized deer populations would likely be reduced from the use of GonaCon™, the extent of the reduction would be variable. For example, not all vaccinated deer are prevented from entering into a reproductive state and those deer that were initially prevented from entering into a reproductive state often become reproductively active in subsequent years as the antibody levels neutralizing the GnRH hormone diminish over time. Therefore, the actual decline in the number of deer in a localized population achieved from the use of GonaCon™ would be difficult to predict prior to the use of the reproductive inhibitor. However, because the decline would occur through attrition over time and because the ability of the inhibitor to prevent reproduction diminishes with time, the actual decline in a localized population would be gradual and WS' personnel and other entities could monitor the decline. In addition, the reduction in a local deer population could be fully reversed if deer are no longer vaccinated or provided booster shots and other conditions (*e.g.*, food, disease) are favorable for population growth.

Turner et al. (1993) noted that although contraception in white-tailed deer may be used to limit population growth, it would not reduce the number of deer in excess of the desired level in many circumstances. Turner et al. (1993) further contends that initial population reductions by various other means may be necessary to achieve management goals, and that reproduction control would be one facet of an integrated program. Although immunocontraceptive technology has been effective in laboratories, pens, and in island field applications, it has not been effective in reducing populations of free-ranging white-tailed deer over large geographical areas.

The magnitude of WS' activities to alleviate damage and threats associated with white-tailed deer in the state would be low with the oversight and permitting of WS' activities occurring by the MDWFP. WS' removal of up to 700 white-tailed deer under the proposed action would be extremely low when compared to the annual harvest of white-tailed deer and the statewide population. WS would report all lethal removal, including unintentional removal, to the MDWFP. In addition, WS will evaluate removal, whether intentional or unintentional, cumulatively to ensure activities do not adversely affect white-tailed deer populations in the state.

Feral and Free-ranging Cat Population Information and Effects Analysis

Free-ranging cats are socialized and can be strays, lost or abandoned pets, or pets with homes that are allowed to roam outside. Feral cats, in contrast, are not socialized to humans and are traditionally not kept as pets. Feral cats produce 2 to 10 kittens during any month of the year. An adult female may produce three litters per year where food and habitat are sufficient. Cats may be active during the day but typically are more active during twilight or night. House cats have been reported to live up to 27 years, but feral cats probably average only three to five years. After several generations, feral cats can be considered wild in habits and temperament (Fitzwater 1994, Dutcher et al. 2021).

Feral/free-ranging cats are often the most abundant predators in many suburban and rural areas. They are opportunistic predators and scavengers that feed on rodents, rabbits, shrews, moles, birds, insects, reptiles, amphibians, fish, carrion, garbage, vegetation, and leftover pet food (Fitzwater 1994, Dutcher et al. 2021). The lowest feral cat population in the United States has been estimated at 70 million cats with hundreds of cats per square mile in some urban areas (Mott 2004).

If WS implements Alternative 1, activities could occur to manage damage and threats associated with feral and free-ranging cats in Mississippi when WS receives a request for assistance. As part of an integrated methods approach, WS could employ live-capture methods to alleviate damage or threats of damage associated with feral or free-ranging cats. Once live-captured, WS could transfer custody of the cats to a local animal control facility. After relinquishing the cats to a local animal control facility, the care and the final disposition of the cat would be the responsibility of the animal control facility. WS could also release free-ranging cats unharmed at the site of their capture, such as those cats possessing identification collars. In some cases, WS may use lethal methods to remove cats causing damage or posing a threat of damage.

From FY 2019 through FY 2023, WS did not provide direct operational assistance with feral or free-ranging cats in Mississippi. However, WS has received requests to manage damage or threats of damage associated with feral or free-ranging cats previously. In FY 2016, WS lethally removed three feral cats using a firearm to alleviate damage or threats of damage. WS could unintentionally capture or lethally remove a feral or free-ranging cat that was set to capture a different animal species. Based on previous requests for assistance and in anticipation of receiving additional requests for assistance involving feral or free-ranging cats, WS could lethally remove up to 100 cats annually to address requests for assistance, including cats that could be lethally removed unintentionally during activities targeting other animal species.

The statewide population of feral and free-ranging cats in Mississippi is unknown. Although population estimates are not available, cats are generally prolific breeders and are generally abundant in most areas where they occur. Because WS' activities would be restricted to specific local sites, WS' limited removal of cats would have minimal effects on local populations or the overall population in Mississippi. However, some local populations may be temporarily reduced at a site if cats were removed using non-lethal or lethal methods. In those cases where cats were causing damage or where cats were a nuisance and complete removal of the local population could be achieved, this could be considered as providing some benefit because cats are not considered part of the native ecosystem.

Feral and Free-ranging Dog Population Information and Effects Analysis

Free-ranging dogs are socialized and can be strays, lost or abandoned pets, or pets with homes that are allowed to roam outside. Feral dogs, in contrast, are not socialized to humans and are traditionally not kept as pets. Like domestic dogs, feral and free-ranging dogs manifest themselves in a variety of shapes, sizes, colors, and even breeds. McKnight (1964) noted German shepherds, Doberman pinschers, and collies are the breeds that most often become feral. Most feral dogs today are descendants of domestic dogs that appear similar to dog breeds that are locally common (Green and Gipson 1994). The primary feature that distinguishes feral from domestic dogs is the degree of reliance or dependence on humans, and in some respect, their behavior toward people. Feral dogs survive and reproduce independently of human intervention or assistance. While it is true that some feral dogs use human garbage for food, others acquire their primary subsistence by hunting and scavenging like other wild canids.

Feral and domestic dogs often differ markedly in their behavior toward people. Scott and Causey (1973) based their classification of those two types by observing the behavior of dogs while confined in cage traps. Domestic dogs usually wagged their tails or exhibited a calm disposition when a human approached, whereas most feral dogs showed highly aggressive behavior, growling, barking, and attempting to bite. Some dogs were intermediate in their behavior and could not be classified as either feral or domestic based solely on their reaction to humans. Because people often pursue, shoot at, or trap feral dogs, their aggressive behavior toward people is not surprising (Green and Gipson 1994).

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

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

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

When receiving requests for assistance associated with feral and free-ranging dogs, WS would follow WS Directive 2.340. WS would primarily provide technical assistance to requesters when those requesters were seeking assistance with dogs. WS would refer most requests for assistance to a local animal control facility because requesters are often unable to determine if a dog was feral or a free-ranging pet. In most cases, WS would employ live-capture methods to alleviate damage or threats of damage associated with dogs. Once live-captured, WS would transfer custody of the dogs to a local animal control facility. After relinquishing the dogs to a local animal control facility, the care and the final disposition of the dog would be the responsibility of the animal control facility.

From FY 2019 through FY 2023, WS did not provide direct operational assistance with feral or free-ranging dogs in Mississippi. During FY 2019, WS unintentionally captured a feral or free-ranging dogs in a cable device that WS released unharmed. Based on previous requests for assistance and in anticipation of receiving additional requests for assistance, WS could lethally remove up to 100 feral and free-ranging dogs per year under the proposed action alternative. WS could also remove feral dogs and free-ranging dogs unintentionally during other damage management activities; however, WS does not anticipate the lethal removal of feral and free-ranging dogs to exceed 100 dogs annually.

Based upon the above information, WS' limited lethal removal of feral and free-ranging dogs should have no adverse effects on overall populations in Mississippi. Any activities conducted by WS involving lethal control actions would be restricted to isolated individual sites. Some local populations may be temporarily reduced because of removal activities aimed at reducing damage at a local site. In those cases where feral dogs were causing damage or posing as a nuisance and complete removal of the local population could be achieved, this would be considered as providing some benefit to the natural environment because feral and free-ranging dogs are not considered part of the native ecosystem.

Additional Target Species

In addition to those mammal species discussed previously, WS has addressed limited numbers of woodchucks, southern flying squirrels, Eastern gray squirrels, and fox squirrels previously or WS anticipates addressing a limited number of those species under the proposed action alternative. Requests for assistance associated with those species would often occur infrequently or would involve only a few individuals. Under the proposed action alternative, WS could receive requests for assistance to use lethal methods to remove those species when non-lethal methods were ineffective or were determined to be inappropriate using the WS Decision model.

Based on previous requests for assistance and the removal levels necessary to alleviate those requests for assistance, WS would not lethally remove more than 10 individuals of those species annually. WS' personnel could also lethally remove those species unintentionally during activities targeting other animal species; however, the total annual removal by WS would not exceed 10 individuals of each species. WS does not expect the annual removal of those species to occur at any level that would adversely affect populations of those species. Removal would be limited to those individuals deemed causing damage or posing a threat.

Eastern gray squirrels and fox squirrels have annual hunting seasons that allow people to harvest those species in the state. Woodchucks are an unregulated species in the state and removal can occur at any time to alleviate damage or threats of damage. If WS lethally removed up to 10 individuals of each of those species to alleviate damage or threats of damage, the removal would be of low magnitude when compared to the number of those species harvested each year. In addition, the removal of up to 10 individuals of each of those species would be of extremely low magnitude when compared to the statewide population of those species. Densities of those species in the state are not low. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of those species annually would have no effect on the ability of those persons interested to harvest those species.

WS could also receive requests for assistance associated with feral or free-ranging mammals, such as domestic animals or pen-raised animals. For example, WS could receive a request to remove fallow deer for disease testing that have escaped from a hunting enclosure. Additional species that entities could request WS to provide assistance with include feral or free-ranging burros, cattle, goats, horses, fallow deer, and other non-native mammals that have escaped an enclosure or were released due to a natural disaster. While WS does not currently expect to lethally remove any of those species, the MDWFP and/or the MDAC could request WS' assistance with unique situations where a small number of those mammals have escaped or were released. Those occasions could include the accidental release of feral animals onto airport properties or animals that have escaped from fenced enclosures. In addition, the MDWFP and/or the MDAC could request WS' assistance as part of an incident response, such as the accidental release of domestic or exotic mammals from vehicle wrecks.

There may also be additional need for removing other mammal species in the event of an animal disease outbreak to limit the spread of the disease. As part of the proposed program, WS could provide assistance, upon request, involving exotic and domestic mammals not specifically listed in this EA in emergencies to alleviate threats to human health and safety. Any lethal removal requested would target specific individual mammals and removal would not reach a magnitude where adverse effects would occur to a species' population based on the limited scope of the removal. In most cases, the removal would be limited to a few individuals and removal would likely occur by other entities in the absence of WS' involvement.

Effects On the Public's Esthetic Enjoyment of Target Mammal Species

Public opinion about the best ways to reduce conflicts between people and animals is highly variable, making the implementation and conduct of damage management programs extremely complex. Some people express concerns that managing damage caused by the target mammal species could interfere with their enjoyment of recreational activities and that WS activities would result in the loss of esthetic benefits of mammals to the public.

People generally regard animals as providing economic, recreational, and esthetic benefits (Decker and Goff 1987), and the mere knowledge that animals exist is a positive benefit to many people. Esthetics is the philosophy dealing with the nature of beauty, or the appreciation of beauty. Therefore, esthetics is truly subjective in nature, dependent on what an observer regards as beautiful. The human attraction to animals likely started when people began domesticating animals. The public today share a similar bond with animals and/or wildlife in general and in modern societies, a large percentage of households have indoor or outdoor pets. However, some people may consider individual wild animals as "*pets*" or exhibit affection toward those animals, especially people who enjoy viewing animals. Therefore, the public reaction can be variable and mixed to animal damage management because there are numerous philosophical, esthetic, and personal attitudes, values, and opinions about the best ways to manage conflicts/problems between people and animals.

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

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

In 2011, the USFWS and the United States Department of Commerce (2011) determined nearly 1.4 million people participated in wildlife-associated recreation in Mississippi, including hunting, fishing, and wildlife watching. In total, people spent over $2.6 billion on wildlife recreation in Mississippi during 2011 (USFWS and the United States Department of Commerce 2011).

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

In the wild, few animals in the United States have life spans approaching that of people. Mortality is high among wildlife populations and specific individuals among a species may experience death early in life. Mortality in wildlife populations is a natural occurrence and people who form affectionate bonds with animals often experience loss of those animals over time. A number of professionals in the field of psychology have studied human behavior in response to attachment to pet animals (Gerwolls and Labott 1994, Marks et al. 1994, Zasloff

1996, Ross and Baron-Sorensen 1998, Archer 1999, Meyers 2000). Similar observations are probably applicable to close bonds that could exist between people and wild animals.

As observed by researchers in human behavior, normal human responses to loss of loved ones proceed through phases of shock or emotional numbness, sense of loss, grief, acceptance of the loss or what cannot be changed, healing, and acceptance and rebuilding, which leads to resumption of normal lives (Lefrancois 1999). Those people who lose companion animals, or animals for which they may have developed a bond and affection, can proceed through the same phases as with the loss of human companions (Gerwolls and Labott 1994, Boyce 1998, Meyers 2000). However, they usually establish a bond with other individual animals after such losses. Although they may lose the sense of enjoyment and meaning from the association with those animals that die or are no longer accessible, they usually find establishing an association with new individual animals or through other relational activities to be similarly meaningful (Weisman 1991). Through this process of coping with the loss and establishing new affectionate bonds, people may avoid compounding emotional effects resulting from such losses (Lefrancois 1999).

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

Even in the absence of any involvement by WS, other entities could conduct activities to alleviate damage or threats of damage. Because other entities could remove mammals causing damage or posing a threat of damage, the involvement of WS in removing those mammals would not likely be additive to the number of mammals that could be removed in the absence of involvement by WS. In addition, activities that could occur by WS would occur on a relatively limited portion of the total area in Mississippi, and the portion of various mammal species' populations removed would typically be low (see Section 3.1.1 in the EA and Section I in Appendix D). In localized areas where WS removes a mammal or mammals, dispersal of mammals from adjacent areas typically contributes to repopulation of the area. The amount of time required to repopulate an area would vary and would depend on the level of removal and mammal population levels in nearby areas. Most of the target species addressed in this EA are relatively abundant. As discussed previously, the effects on target mammal populations from damage management activities would be relatively low if WS implemented Alternative 1 and opportunities to view, hear, or see evidence of mammals would still be available over the majority of land area of the state.

Effects on the Ability of the Public to Harvest Mammal Species

The populations of most of the mammal species addressed in this EA are sufficient to allow for annual harvest seasons that typically occur during the fall and winter. Hunting and trapping seasons are established by the MDWFP. For many mammal species considered harvestable during hunting and/or trapping seasons, the MDWFP may publish reports on the estimated number of mammals that people harvested during the season.

The magnitude of lethal removal addressed would be low when compared to the mortality of those species from all known sources. When WS' proposed removal of mammals was included as part of the known mortality of those species and compared to the estimated populations, the impact on those species' populations were below the level of removal required to lower population levels.

With oversight of mammal populations by the MDWFP, the number of mammals that WS could remove annually would not limit the ability of those persons interested to harvest those mammal species during the regulated season. All removal by WS would be reported to the MDWFP annually to ensure removal by WS could be incorporated into population management objectives established for mammal populations. Based on the limited removal proposed by WS and the oversight by the MDWFP, WS' removal of mammals annually would have no effect on the ability of those persons interested to harvest mammals during the regulated harvest season.

Effects Of WS' Activities on Biodiversity and Ecosystem Resilience

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

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

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

Most evaluations of the impacts of predator removal or loss on biodiversity involve complete removal of predators over the course of years (*e.g.*, see Berger et al. 2001, Beschta and Ripple 2006, Beschta and Ripple 2008, Frank 2008, Gill et al. 2009, Beschta and Ripple 2012*a*). Henke (1992, 1995) documented a decline in species richness and rodent diversity and increases in relative abundance of badgers, bobcats, and gray fox in areas of Texas where coyote removal occurred continually throughout the year, which resulted in a sustained 48% reduction in the local coyote population. Cottontail rabbit (*Sylvilagus floridanus*) density and raptor richness, species diversity, and density did not differ between control and treatment areas. However, the continual removal of coyotes throughout the year that occurred by Henke (1992) would not normally occur if WS implemented the proposed action alternative.

Similarly, the degree of predator removal (exclusion or intensive population reduction efforts via use of toxicants sustained throughout the year) was far greater in the study by Wallach et al. (2010) than would occur if WS implemented the proposed action alternative. Based on findings by Gese (2005), both the number of coyotes and the number of coyote packs in areas with similar activities to those that WS could conduct had returned to pre-removal levels within eight months while Conner and Morris (2015) indicated that coyote immigration may replace coyotes removed within three to four months. Although there was evidence of a reduction in the average age of the local coyote population, there was no evidence that this resulted in an increase in coyote densities above pre-removal levels.

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

WS does not attempt to eradicate or suppress any species of native wildlife. WS would only use available methods to target individual animals or groups of animals identified as causing damage or posing a threat of damage. Any reduction of a local population or group of animals is frequently temporary because immigration from adjacent areas or reproduction replaces the animals removed. WS would only provide assistance after receiving a request to manage damage or threats of damage. WS would not attempt to suppress mammal populations across broad geographical areas at such intensity levels for prolonged durations that significant ecological effects would occur. The goal of WS would not be to reduce mammal populations but to manage damage or threats associated with specific individuals of a species.

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

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

Based on this information, WS concludes that potential impacts associated with the implementation of the proposed action alternative would not be of sufficient magnitude or scope at the local or state level to adversely affect biodiversity or ecosystem resilience.

Potential to Cause Trophic Cascades, Including Mesopredator Release

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

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

2009, Miller et al. 2012). Normally, competition and intraguild predation (Polis et al. 1989) are thought to control mesopredators in the presence of apex predators and limit their effects on ecosystems.

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

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

In the Midwest, changes in coyote activity influenced white-tailed deer activity with associated impacts to plant communities (Waser et al. 2014). However, as with most ecosystems, the nature and magnitude of these types of relationships varies. For example, Maron and Pearson (2011) did not detect evidence that the presence of vertebrate predators fundamentally affected primary production or seed survival in a grassland ecosystem. In general, predators may prolong the low points in rodent population cycles and spread the duration of the population peaks. Predators generally do not control rodent populations (Clark 1972, Wagner and Stoddart 1972, Keith 1974). It is more likely that prey abundance regulates to some degree the populations of predators (Clark 1972, Wagner and Stoddart 1972).

Data on the impacts of coyotes and coyote removal on prey populations are mixed. Wagner (1988) reviewed literature on predator impacts on prey populations and concluded that such impacts vary with the locale. In two studies conducted in south Texas (Beasom 1974, Guthery and Beasom 1977), intensive short-term predator removal was employed to test the response of game species to reduced coyote abundance. At the same time, Beasom (1974) and Guthery and Beasom (1977) monitored rodent and lagomorph species. A marked reduction in coyote numbers apparently had no notable effect on the populations of rabbits or rodents in either study.

Similarly, Neff et al. (1985) noted that reducing coyote populations on their study area in

Arizona to protect pronghorn antelope fawns had no apparent effect on the rodent or rabbit population. Wagner and Stoddart (1972) noted that coyote predation was a major source of mortality in a black-tailed jackrabbit (*Lepus californicus*) population that may have played an important part in population trends, but they made no connection between predator damage management, jackrabbit mortality, or coyote population size. In fact, any moderating effects from coyotes on jackrabbit densities in the Wagner and Stoddart (1972) study occurred despite activities that were considerably more intensive (aerial shooting, trapping for bounties and pelts, and the use of poison bait stations) than what normally occurs as part of current activities conducted by WS).

In some ecosystems, prey species, such as snowshoe hares (*Lepus americanus*), increased to the point that they depleted vegetative food sources despite predation. In others, coyotes may limit jackrabbit density, while food shortages do not limit jackrabbit abundance (Wagner 1988, Stoddart et al. 2001). Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality in the Curlew Valley of Utah, which may have caused a decline in the local jackrabbit population in the Valley. Wagner and Stoddart (1972) made no connections between coyote removal and jackrabbit mortality or coyote populations. The coyote population in the study conducted by Wagner and Stoddart (1972) was subject to more sustained and intensive removal (aerial shooting, trapping for bounties, pelt harvest, and the use of poisoned baits that were placed in the fall and recovered in the spring) than would occur if WS implemented this alternative.

Any moderating effects of coyotes on jackrabbit populations occurred even though the population was subject to intensive removals. Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote populations and jackrabbit populations in northern Utah and southern Idaho. Both Wagner and Stoddart (1972) and Clark (1972) concluded that coyote populations seemed to respond to an abundance of jackrabbits. Complexity of the system and the range of available prey species may also influence the relationships between predators and prey. When a broad range of prey species are available, coyotes will generally feed on all species available; therefore, coyote populations may not vary with changes in the availability of a single prey species (Knowlton 1964, Clark 1972).

Intensive studies of the snowshoe rabbit population cycles by Krebs et al. (2001) reflect the complexity of predator and prey relationships. Krebs et al. (2001) determined a 10-year cycle in snowshoe hares was the result of an interaction between predation and food supplies, with predation playing the principal role in driving the cycle in the hare population. Krebs et al. (2001) found a link between mammalian predator abundance (primarily coyotes and Canada lynx (*Lynx canadensis*)) and the abundance of hares with predator abundance lagging the hare cycle by one to two years. Although Canada lynx and coyotes were key predators influencing hare survival, many species of predators were involved in the cycle, and Krebs et al. (2001) were unable to pinpoint the specific role of any one species of predators. The importance that a range of predators can have on the 10-year cycle of hares occurs on Anticosti Island on the St. Lawrence River in eastern Canada. Canada lynx no longer occur on the island, but the hare cycle persists, likely due to compensatory predation by other species (Keith 1963, Stenseth et al. 1997). Impacts of food in the studies reported by Krebs et al. (2001) appeared to be indirect and were associated with declines in body condition, which may influence chronic stress, the ability of hares to avoid predators, and reproductive output.

The study also implicated long-range movement of predators as the potential mechanism behind the synchronicity of the snowshoe hare population cycles over large geographic regions. As indicated previously, the role of predators and food supplies appears to vary. Stevens (2010) provided an example of a system in Sweden in which red fox prey on voles, grouse, and hares. Like the snowshoe hare and lynx example, the fox and prey species appear to have linked population cycles with changes in predator populations following changes in prey populations. However, unlike the snowshoe hare example, forage availability appeared to have a more direct impact on prey populations. Based on forage switching from preferred to less preferred forage, in this system, the availability of forage also acts as a limiting factor on prey populations. When preferred food was scarce, individuals grew more slowly and reproduced less.

Keith (1974) concluded that: 1) during cyclic declines in prey populations, predation has a depressive effect and as a result, the prey populations may decline further and be held for some time at relatively low densities, 2) prey populations may escape this low point when predator populations decrease in response to low prey populations, and 3) since rabbit and rodent populations increase at a faster rate than predator populations, factors other than predation must initiate the decline in populations. Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote and black-tailed jackrabbit populations in northern Utah and southern Idaho. Both Wagner and Stoddart (1972) and Clark (1972) concluded that coyote populations seemed to respond to an abundance of jackrabbits. When a broad range of prey species are available, coyotes will generally feed on all species available; therefore, coyote populations may not vary with changes in the availability of a single prey species (Knowlton 1964, Clark 1972).

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

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

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

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

Therefore, implementation of this alternative would not result in the extirpation or suppression of any native predator population. The number of animals from a species' population WS could lethally remove annually under the proposed action alternative would be of low magnitude and activities would occur in relatively small or isolated geographical areas. Based on this information, WS concludes that potential impacts associated with the implementation of

Alternative 1 would not be of sufficient magnitude or scope at the local or state level to cause trophic cascades or result in mesopredator release.

Wildlife Disease Surveillance, Monitoring, and Management

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

In many cases, disease sampling strategies in Mississippi involve sampling live-captured mammals that could be released on site after sampling occurs. 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 because those mammals would be released unharmed on site. In addition, opportunistic sampling may occur of mammals that are sick, dying, or harvested by hunters, which would not result in the additive lethal removal of mammals that would not have already occurred in the absence of disease sampling. Therefore, in most cases, the sampling of mammals for diseases would not adversely affect the populations of any of the mammals addressed in this EA nor would sampling mammals result in any lethal removal of mammals. Most disease sampling would occur ancillary to other wildlife damage management activities (*i.e.*, disease sampling would occur after wildlife have been captured or lethally removed for other purposes) or hunter harvest.

However, WS could conduct purposeful lethal removal of certain mammal species to manage risks associated with the detection of a disease. For example, if African swine fever were detected, WS could remove feral swine around the detection site for sampling and testing and to limit the potential spread of the disease. Any purposeful lethal removal of target mammal species for disease sampling and to limit the potential to spread a disease would occur within the impacts discussed previously for individual species.

Alternative 2 - WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

If WS implements Alternative 2, WS would be available to provide both technical assistance and direct operational assistance to those persons requesting assistance with managing damage and threats caused by target species in Mississippi. When formulating a management strategy using the WS Decision Model to address damage and threats of damage, WS would only consider the use and/or recommendation of non-lethal methods. The effects on the populations of target species associated with WS providing technical assistance during the implementation of Alternative 2 would be similar to those effects discussed for Alternative 3. Therefore, to reduce redundancy, the effects associated with WS providing technical assistance that would occur if WS implements Alternative 2 occur in the discussion for Alternative 3.

Under Alternative 2, WS would only use non-lethal methods to resolve damage or threats of damage associated with target species in Mississippi. No intentional lethal removal of target mammal species would occur by WS. Section I in Appendix C discusses the non-lethal methods available to reduce damage caused by target mammal species. Generally, non-lethal methods would disperse, exclude, or live-capture target mammal species. Methods intended to disperse target species from an area are generally visual or auditory deterrents, such as lights, lasers, pyrotechnics, and propane cannons. Exclusion methods would prevent target species from accessing a resource and could disperse those target species to other areas where resources are unprotected. Exclusion methods could include fencing, netting, and other barriers, such as placing fencing around bee hives to prevent access by bears. WS could also live-capture target species. After capturing a target species, WS could then transfer custody of the animal over to another entity (*e.g.*, a local animal control facility), translocate the animal to appropriate habitat for release, or attach a radio and/or GPS transmitter and release the target animal at the same site of capture. WS could continue to use aircraft and Unmanned Aerial Vehicles (UAVs) to survey, monitor, and track mammals in Mississippi. GonaCon™ would also be available to manage localized populations of white-tailed deer and equines.

DIRECT EFFECTS ON TARGET POPULATIONS ASSOCIATED WITH IMPLEMENTING ALTERNATIVE 2

Effects on the populations of target mammal species in the state from WS' use of non-lethal methods would be minimal. The use of non-lethal methods would generally have minimal effects on the overall population of a target species because those methods would not harm individual animals of a target species. WS' personnel would not employ non-lethal methods over large geographical areas or apply those methods at such an intensity that target species would be unable to access essential resources (*e.g.*, food sources, habitat) for extended durations.

The intent associated with the use of auditory and visual deterrents is to elicit a flight response by scaring target species from an area where damage is occurring or where damage could occur. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of individual target species or the ability of a target animal to survive, especially if the exposure to the stressor was chronic. If stress occurs to a target animal from the scaring associated with hazing, the negative effects associated with causing a flight response could be exacerbated by other deleterious stressors already occurring (*e.g.*, disease, food availability). The stress from hazing could negatively affect the health of a target animal, interfere with the raising of young, and/or increase energy needs. A similar concern would occur when using exclusion methods, which could prevent target species from accessing a resource (*e.g.*, food source, nesting locations).

WS could also live-capture target animals. When using methods to live-capture a target species, injuries or death could occur during the process of capturing a target animal or while immobilizing an animal. Constantly monitoring and addressing captured target animals immediately after capture can reduce the likelihood of injuries and death. In addition, making appropriate modification to live-capture methods can reduce injuries. After a target animal has been live-captured, WS could then relinquish custody of the animal over to another entity (*e.g.*, a local animal control facility)[8], translocate the animal to appropriate habitat for release, or attach a

[8]Primarily associated with feral/free-ranging cats and dogs.

radio and/or GPS transmitter and release the target animal at the same site of capture. WS could use immobilizing drugs to handle and transport target animals if WS implements Alternative 2. A veterinarian, either on staff or on an advisory basis, would be involved in the oversight of WS' use of immobilizing drugs in accordance with the Animal Medicinal Drug Use Clarification Act. In addition, WS' personnel who handle and administer immobilizing drugs would receive training in accordance with WS Directive 2.430.

WS could attach identifying markers (*e.g.*, ear tags) for identification purposes when attaching a radio and/or GPS transmitter to a target animal. Live-capturing and attaching identifying markers would only occur after WS or another entity received the appropriate permits from the MDWFP to attach those identifying markers on target species. Because the intent of using identifying markers is to monitor natural movement patterns and to identify individual target species, researchers have designed those methods to allow for natural movements and limit adverse effects on the target species. WS anticipates using identifying markers on a very limited basis because of the time and cost required to live-capture target species.

The use of UAVs by WS to monitor and/or haze mammals would not occur at such frequency or at an intensity level that would adversely affect mammal populations. UAVs used by WS would spend a very small amount of time at any location during surveys and/or tracking mammals. Similarly, the use of aircraft by WS to monitor and/or track mammals would not occur at such frequency or at an intensity level that would adversely affect mammal populations. Aircraft used by WS would spend a very small amount of time at any location during surveys and/or tracking mammals.

Overall, the use of non-lethal methods by WS in Mississippi to exclude, capture, or haze target species would have no effect on the overall population of a mammal species because those methods would not harm individual mammals. WS would not employ non-lethal methods over large geographical areas at such intensity levels that resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope. Therefore, direct effects that relate to a mammal population would not occur by WS from implementation of Alternative 2.

WS could also use GonaCon™ to manage localized white-tailed deer populations. A localized population reduction would occur over time through attrition (*i.e.*, the number of new deer recruited into the localized population is not enough to replace the number of deer that die annually). Because the effects of GonaCon™ are generally reversible if white-tailed deer do not receive a booster shot periodically, the reduction in a local population of deer from the use of GonaCon™ could be maintained at appropriate levels and can be fully reversed if deer are no longer vaccinated or provided booster shots and other conditions (*e.g.*, food, disease) are favorable for population growth. Therefore, WS the use of GonaCon™ could result in the reduction of a localized white-tailed deer population but would not result in adverse impacts to the white-tailed deer population in Mississippi (see further discussion under the white-tailed deer information and effects analysis under Alternative 1 in Section I of Appendix D).

INDIRECT EFFECTS ON TARGET SPECIES POPULATIONS ASSOCIATED WITH IMPLEMENTING ALTERNATIVE 2

As discussed previously, the use of non-lethal methods by WS to exclude, capture, or haze target species would have no effect on populations of target species. WS would not employ non-lethal methods over large geographical areas at such intensity levels that resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope. Therefore, indirect effects that relate to the population of a target species would not occur by WS from implementation of Alternative 2.

Implementation of Alternative 2 by WS would not prevent other entities from using most of the lethal methods identified in Appendix C to take target species in Mississippi. WS anticipates the lethal take of target species would continue to occur by other entities if WS implements Alternative 2 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1. Therefore, WS anticipates the indirect effects associated with implementing Alternative 2 would be similar to those indirect effects discussed for Alternative 1 because the lethal take of target species could continue to occur by other entities.

EFFECTS ON TARGET SPECIES POPULATIONS FROM IMPLEMENTING ALTERNATIVE 2

WS does not anticipate any significant effects to occur associated with WS' use of non-lethal methods even when considered with the use of non-lethal methods by other entities. Although non-lethal methods would likely elicit a flight response, the use of non-lethal methods by all entities is not likely to rise to a level that would have an effect on the population of a target species. The continued use of many non-lethal methods can often lead to the habituation of target species to those methods (*i.e.*, showing no response or limited movements), which can decrease the effectiveness of those methods (*e.g.*, see Conover 2002, DeVault et al. 2017, Glow et al. 2020, Young et al. 2022).

WS does not anticipate any significant effects to the white-tailed deer population from WS' potential use of GonaCon™. People could continue to harvest white-tailed deer during annual hunting seasons in the state and to alleviate damage when permitted by the MDWFP. WS could use GonaCon™ to manage a localized white-tailed deer population that are generally not subject to hunting or where limited hunting opportunities exist, such as urban areas or enclosed facilities. In addition, a population reduction occurs slowly over time through attrition; therefore, the local population can be monitored and maintain at a desired level because the effects of the reproductive inhibitor are generally reversible.

Although implementation of this alternative would limit WS to using only non-lethal methods, entities other than WS could continue to use lethal methods. Implementation of Alternative 2 by WS would not prevent the MDWFP from continuing to authorize the lethal take of target species in Mississippi. People could continue to harvest some mammal species during annual hunting and/or trapping seasons in the state.

WS anticipates the lethal take of mammals would continue to occur by other entities if WS implements Alternative 2 and would likely occur at levels similar to the take that would occur if WS implemented Alternative 1. Therefore, WS anticipates the effects associated with implementing Alternative 2 would be similar to those effects discussed for Alternative 1 because the lethal take of mammals in the state would continue to occur by other entities.

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

Under the technical assistance only alternative, WS would recommend an integrated method approach similar to Alternative 1 and Alternative 2; however, WS would not provide direct operational assistance under this alternative. Using information that a requester provides or from a site visit by an employee, WS' personnel would recommend methods and techniques based on their use of the WS Decision Model. In some instances, information provided to the requester by WS could result in tolerance/acceptance of the situation. In other instances, WS would discuss and recommend damage management options.

EFFECTS ON MAMMAL POPULATIONS ASSOCIATED WITH IMPLEMENTING ALTERNATIVE 3

When discussing damage management options with the person requesting assistance, WS' personnel could recommend and demonstrate the use of both non-lethal and lethal methods that were legally available for use to alleviate damage. People receiving technical assistance from WS could implement methods recommended by WS, employ other methods not recommended by WS, seek assistance from other entities, or take no further action. If WS implements Alternative 3, WS would have no direct effect on mammal populations because WS' personnel would not provide direct operational assistance.

Despite WS not providing direct operational assistance to resolve damage and threats associated with mammals, those people experiencing damage caused by mammals could alleviate damage by employing legally available methods or by seeking assistance from other entities. Implementation of Alternative 3 by WS would not prevent other entities from using lethal and non-lethal methods. Many of the methods discussed in Appendix C would be available for other people to use. WS anticipates the lethal removal of mammals would continue to occur by other entities if WS implements Alternative 3 and would likely occur at levels similar to the lethal removal that would occur if WS implemented Alternative 1 or Alternative 2. Removal of mammals by other entities would likely be similar because removal could occur when authorized by the MDWFP and removal would continue to occur during the harvest season for those species. Similarly, tribal authorities would determine when removal could occur on their tribal lands.

Therefore, WS anticipates the effects associated with implementing Alternative 3 would be similar to those effects discussed for Alternative 1 and Alternative 2 because activities to manage damage that mammals can cause in the state would continue to occur by other entities. In addition, the harvest of mammals during the annual hunting and trapping seasons would continue to occur. With the oversight of the MDWFP, it is unlikely that implementation of Alternative 3 by WS would adversely affect mammal populations.

Alternative 4 - WS would not provide any assistance with managing damage caused by mammals in Mississippi

If WS implements Alternative 4, WS would have no direct involvement with any aspect of addressing damage caused by mammals and would provide no technical assistance. When contacted about damage or the threat of damage caused by mammals, WS would refer those people to other entities, such as the MDWFP and/or private entities.

II. EFFECTS OF THE ALTERNATIVE APPROACHES ON THE POPULATIONS OF NON-TARGET WILDLIFE SPECIES, INCLUDING THREATENED AND ENDANGERED SPECIES

A concern is the potential impacts to non-target species, including threatened or endangered species, from the use of methods to resolve damage caused by mammals. When using methods, WS could unintentionally live capture, exclude, disperse, or kill non-target animals. Discussion on the potential effects of the alternative approaches on the populations of non-target animal species occurs below for each of the alternative approaches identified in Section 2.5 of the EA.

Alternative 1 - WS would continue the current integrated methods approach to managing damage caused by mammals in Mississippi (Proposed Action/No Action)

If WS implements Alternative 1, WS would provide both technical assistance and direct operational assistance to people requesting assistance. When providing direct operational assistance, WS' employees would use lethal and/or non-lethal methods in an integrated methods approach to reduce damage and alleviate risks of damage associated with mammals.

EFFECTS ANALYSIS ON NON-TARGET POPULATIONS ASSOCIATED WITH IMPLEMENTING ALTERNATIVE 1

WS' personnel have experience and receive training in wildlife identification, which allows them to identify individual species and to identify damage or recognize damage threats associated with mammals. In addition, WS' personnel have knowledge in the use patterns of methods available to resolve animal damage, which allows them to select the most appropriate method(s) to address animal damage and minimize impacts on non-target species. WS' personnel use a decision-making process for evaluating and responding to requests for assistance detailed in the WS Decision Model (see WS Directive 2.201), which Slate et al. (1992) describes in more detail. Using the WS Decision Model, WS' personnel would formulate a management strategy, which would include the method or methods the employee determines to be practical for use to alleviate damage or reduce risks caused by the target mammal species. When determining the appropriate method or methods, WS' personnel would consider risks to non-target animals from the use of a method or methods.

Despite WS' efforts to reduce risks to non-target animals, the use of a method or methods could exclude, disperse, capture, or kill non-target animals unintentionally. WS' employees would release non-target animals live-captured in traps unless it was determined that the animal would not survive and/or that the animal could not be released safely. A discussion of the risks to non-target animals and the potential effects on the populations of non-target animals if WS implements Alternative 1 occurs below.

Risks to non-target animals associated with available methods

The risks to non-target animals associated with WS providing technical assistance during the implementation of Alternative 1 would be similar to those risks to non-target animals discussed for Alternative 3. Therefore, to reduce redundancy, the effects associated with WS providing technical assistance that would occur if WS implements Alternative 1 occur in the discussion for Alternative 3. Similarly, the risks to non-target animals from the use of non-lethal methods during the implementation of Alternative 1 would be similar to those risks to non-target animals discussed for Alternative 2. To reduce redundancy, the risks to non-target animals from the use of non-lethal methods if WS implements Alternative 1 occur in the discussion for Alternative 2.

Regarding risks to non-target animals, the primary risk would be associated with lethal methods because their use could result in the death of a non-target animal. Section II in Appendix C describes the lethal methods that WS' personnel could choose to implement. Lethal methods that WS' employees could use and/or recommend include body-grip traps, cable devices, firearms, euthanasia after live capture, gas cartridges, and the recommendation of harvest during annual hunting and trapping seasons. In addition, there could be risks to non-target animals from WS' use of lead ammunition. Risks to non-target animals associated with those methods occur below.

Body-grip traps

WS' personnel would primarily use body-grip traps to target medium to smaller predatory mammal species, such as raccoons. WS can minimize the risk of capturing non-target animals by the selection of trap size for the target animal, adjusting the location of the trigger, selection of the proper bait, lure or attractant, and appropriate trap placement. WS can increase the selectivity of body-gripping traps by placement, trap size, trigger configurations, and baits. When using body-gripping traps, risks of non-target capture can be minimized by using recessed sets (placing trap inside a cubby, cage, or burrow), restricting openings, or by submerging traps. For example, when targeting beaver, WS can set body-grip traps underwater to minimize risks to non-target animals. Choosing appropriately sized traps for the target species can also exclude non-target animals by preventing larger animals from entering and triggering the trap. Pursuant to WS Directive 2.450, WS' employees must post appropriate warning signs on the main entrances or commonly used access points to areas where employees are using body-grip traps to warn people, especially pet owners.

Lures and food attractants are sometimes used to encourage target animals to enter and trigger body-grip traps; however, relatively small quantities are used, and those items are not considered hazardous. Food attractants consist of food items that are preferred by target animals. Therefore, lures and attractants would not be substances that bioaccumulate in the environment or cause environmental harm.

Cable devices

WS could use cable devices to capture primarily feral swine, coyotes, and other similarly sized target mammal species. The risk of live-capturing or killing non-target animals does occur when using cable devices. Risks would be greatest for animals that frequent the area where WS placed cable devices and travel along the same trails as the target species. WS could use cable devices in a variety of habitats; thus, many species of wildlife could be exposed to cable devices used by WS. As the amount of time between capture and checking the device increases, the risk of injuries occurring also likely increases. The selectivity of cable devices can be improved by design and using techniques designed to reduce the risk to non-target animals (Association of Fish and Wildlife Agencies 2009, Short et al. 2012). Several designs and techniques would be employed by WS to reduce the risk of capturing or killing non-target animals.

One commonly employed technique to minimize risk involves adjusting the loop size of the cable device. The loop size used when setting a cable device can minimize the likelihood of capturing animals either larger or smaller than the intended species (Association of Fish and Wildlife Agencies 2009, Short et al. 2012). The height of the snare loop from the ground can also minimize risks by positioning the loop at a level most apt to minimize risk of capture for other animals (Association of Fish and Wildlife Agencies 2009, Short et al. 2012, USDA 2019*e*). Adjusting the loop height can minimize capture of animals that are either taller or shorter than the target species. Raising the loop can allow smaller animals to pass under the under the cable device. Conversely, lowering the height of the loop can allow larger animals to step over the loop. However, lowering the height of the loop too much could result in capturing a larger animal by the leg (Association of Fish and Wildlife Agencies 2009).

Various natural or other materials can be used as "*guide sticks*" to direct the target animal through a cable restraint or to guide a non-target animal over, under, or around the snare (Association of Fish and Wildlife Agencies 2009). Knowledge of the animal species in an area and the behavior of those animals can be critical in deciding whether to use a guide stick when using cable devices. If guide sticks were used, appropriate placement and size must be considered because the placement and size or rigidity of the guide can influence animal behavior (Association of Fish and Wildlife Agencies 2009, USDA 2019*e*). For example, using a large rigid guide stick over the cable device could cause deer to jump over the device and avoid capture; however, placing a large rigid guide stick to high above the cable device could encourage a deer to pass underneath the stick, which would increase the risk of capture (Association of Fish and Wildlife Agencies 2009). Gardner (2010) used a diverting wire with neck snares used for wolves to reduce the risk of capturing moose by placing the additional wire at a height that allowed moose to contact the wire and push the snare away before the moose contacted the cable device.

Baits or lures can be used to attract a target animal to the area where a device has been placed. When deciding on whether to use baits or lures and which ones, consideration is given to non-target animals that may also be attracted to the bait or lure (Knopff et al. 2010). Selecting the appropriate bait or lure can increase or decrease risks of attracting non-target animals to an area where a cable device is set (Association of Fish and Wildlife Agencies 2009, USDA 2019*e*, Association of Fish and Wildlife Agencies 2021).

Loop stops can also be used to minimize the risk of capturing or killing non-target animals in cable devices (Association of Fish and Wildlife Agencies 2009, Etter and Belant 2011, Association of Fish and Wildlife Agencies 2021). Minimum loop stops control the minimum diameter of the loop while maximum loop stops control the maximum diameter of the loop (Association of Fish and Wildlife Agencies 2009, Association of Fish and Wildlife Agencies 2021). Minimum loop stops allow animals smaller than the target animals to escape or allow animals captured in a specific body area, such as the leg, to escape since the loop could only close to minimum diameter. As an example, a minimum loop stop could allow for the capture of a coyote but allow a deer caught by the leg to escape (Association of Fish and Wildlife Agencies 2009). Etter and Belant (2011) compared the efficiency and selectivity of cable devices to live-capture coyotes based on minimum loop stop diameters of 8.9 centimeters and 10.8 centimeters and found the smaller loop stop diameter was more effective at capturing coyotes and avoiding non-target capture.

Adjusting trigger tension on power-activated foot snares can also increase selectivity and reduce risks to non-target animals. Increasing the amount of force required of an animal to activate a foot-depressed trigger or a mouth-pulled trigger could minimize the risk of capturing smaller animals or animals without the ability to apply the necessary force to trigger the snare (Association of Fish and Wildlife Agencies 2009).

Snare "*loading*" is the process of altering the curvature of the snare loop to increase the sensitivity of the loop to closure and once closure of the loop is initiated by the target animal, the loop closes more rapidly. Snare loading is often used to improve the efficiency of capturing a target animal when using passive cable devices but may not be suitable for use in all situations, especially when non-target animals that may encounter the cable device are smaller than the target animal (Association of Fish and Wildlife Agencies 2009). If a smaller animal was passing through the loop of the cable device and bumped or brushed the snare loop, the modified snare loop could close more rapidly; thus, not allowing enough time for the smaller animal to pass completely through the loop. The positioning of a lock on the snare loop can also influence the sensitivity of the loop to closure. Adjusting the position of the lock can increase or decrease the sensitivity of the loop to closure, which can be used to reduce risks of capturing or killing a non-target animal (Association of Fish and Wildlife Agencies 2009).

Breakaway devices on cable devices allow the snare loop to break open when a certain amount of force is applied, which allows the animal to escape from the snare (Association of Fish and Wildlife Agencies 2009). The devices can be used to prevent holding a non-target animal that generates more force than the target animal. For example, when setting snares to capture coyotes, breakaway locks could be used that allow deer to break the device and escape if captured, because deer are able to generate more force than coyotes.

The enclosed foothold trap is designed to target animals that are capable of reaching inside the narrow entrance of the trap (normally 1.5 inches in diameter) to push or pull the trigger, which reduces the risk of non-target animals from being captured, such as dogs or coyotes. The triggers are generally recessed 2 to 3 inches inside the trap, which excludes many animals from reaching inside the narrow entrance and pulling or pushing the trigger.

Firearms

The use of firearms would essentially be selective for target wildlife because identification of the target would occur prior to application. There is a slight risk of misidentifying mammal species, especially when target and non-target species have a similar appearance. There is also a slight risk of unintentional take of non-target animals if a projectile strikes a non-target animal after passing through a target mammal, if misses occur, or if a non-target animal is near a target mammal when using a shotgun. WS' personnel can minimize risks by using appropriate firearms, being aware of what is near or beyond the target mammal, and training to be proficient with the use of a firearm.

Therefore, the unintentional take of a non-target animal in Mississippi using firearms is not likely to occur. Noise associated with the discharge of a firearm, if occurring near a non-target animal or animals could elicit a flight response. However, the use of firearms in proximity to non-target animals is not likely to occur at a high frequency or high magnitude. For harassment to occur from noise associated with the discharge of a firearm, a non-target animal would have to be present within hearing distance at the time an employee discharged the firearm, and the resulting noise would have to elicit a negative response. The use of firearms would frequently take place at night or in the morning/evening, when some mammals may be more active. The use of night vision and/or thermal equipment could be crucial in identifying a target animal species. This equipment would give the shooter the ability to spot animals in complete darkness or low light situations so a positive identification could occur before taking any shot. Personnel could also euthanize target animals using firearms once live captured in traps or restraining cables.

Lead Ammunition

There is a concern about the deposition of lead into the environment from WS use of ammunition in firearms. Risk of lead exposure to animals occurs primarily when animals ingest lead shot or bullet fragments (Pain et al. 2009, Golden et al. 2016, The Wildlife Society 2022). When using a firearm with lead ammunition, lead fragments and shot can become embedded in the organs and tissue during passage of the bullet in the animal. Scavenging birds are particularly vulnerable to the effects of lead because their gizzards grind the lead into smaller pieces and the low gastric pH levels in the gizzard of a bird can dissolve lead, which allows the bloodstream to absorb lead easier. In a review of the lead ammunition effects on terrestrial birds, Pain et al. (2009) documented impacts on 33 raptor species and 30 other species including, but not limited to raptors, ground nesting birds, cranes, and upland game birds. Katzner et al. (2024) also provides a review of lead poisoning risks in raptors. Risks would also occur to carnivorous mammal species that scavenge on carcasses, such as coyotes and bears.

WS has specific ammunition and firearm requirements to maximize performance (accuracy and conveying its full energy to the target and resulting in low or no pass-through), safety, and humaneness (shot placement to result in rapid death) (Caudell et al. 2012). The objective of field personnel is to use the fewest number of shots on a particular targeted animal, with the intent of a humane and efficient kill with one shot. Precision performance of bullets is essential for project efficacy, safety, humaneness (shot placement to result in rapid death) (MacPherson 2005, Caudell et al. 2009), and shot placement to preserve tissues for animal health monitoring. Direction of ricochet/pass-through is difficult to predict (Burke and Rowe 1992) and is a safety concern, especially at airports, near residences, around rocky substrate, and for WS' personnel when shooting during aerial operations. Ammunition that conveys its full energy to the target animal and that results in low or no pass through is needed for reasons of humaneness (instant or near-instant incapacitation) and to reduce safety risks associated with wounded animals.

Challenges associated with lead-free ammunition include that some types of lead-free ammunition are harder than lead ammunition and more likely to ricochet off hard surfaces, which increases the odds of hitting aircraft, personnel, or other unintended targets, and presents unacceptable risks to human safety (APHIS 2012). WS has tested bismuth ammunition for aerial operations but found the product too frangible for safe and effective use. Increased wounding has been associated with lighter bullets (Aebischer et al. 2014). Lead-free alloys require longer bullets to obtain comparable bullet weights. Terminal performance (the performance of the bullet upon striking the target animal) is, in part, determined by bullet weight. Ballistically, a faster rate of twist is usually necessary to stabilize longer bullets, though individual firearm performance varies. Accuracy of non-lead ammunition is less than accuracy of lead ammunition in many of the firearms presently in use by WS in Mississippi. Whereas non-lead ammunition is available in many calibers, its suitability and accuracy in all firearms is not universally equal to lead ammunition. Harder lead-free rifle ammunition is more likely to result in "*non-frangible bullet pass-through*" and failure of the bullet to convey its full energy to the target animal, although similar problems also exist with some types of lead rifle ammunition. In addition to the increased risk of hitting an unintended target, non-frangible pass through also increases the likelihood that the target animal may not be rapidly or instantly killed by the shot and may be considered less humane (APHIS 2012).

Lead-free ammunition is often more expensive than equivalent ammunition using lead. Costs may sometimes be secondary to overriding environmental, legal, public safety, animal welfare, or other concerns, but it is still an issue. Cooperators usually pay a substantial portion of operational program costs and may be unwilling to pay the additional ammunition costs in areas where it is otherwise legal to use lead ammunition.

WS use of lead ammunition, including ammunition used to lethally removal feral swine, is only a small fraction of lead ammunition use by other entities (*e.g.*, hunting, target shooting). WS adheres to all applicable laws governing the use of lead ammunition in WS' activities and landowner/manager desires for lead-free ammunition in their projects. Additionally, WS is working to shift to lead-free ammunition as new lead-free alternatives that meet WS standards for safety, performance, and humaneness are developed and become reliably available in adequate quantities for program use. Therefore, use of lead ammunition by WS is anticipated to decrease over time. WS uses lead-free ammunition when practical, effective, and available to mitigate and/or minimize the effects of lead ammunition on the environment, wildlife, and public health and in compliance with federal, state, territory or tribal regulations on the use of lead ammunition. WS evaluates new lead-free ammunition options as they become available.

Total lead ammunition use in the national WS program as a percentage of total lead use from ammunition in the United States is very low (~0.002%). WS use of lead ammunition is decreasing as WS shifts to lead free alternatives as new lead-free alternatives that meet WS standards for safety, performance, and humaneness become reliably and cost-effectively available in adequate quantities for program use (USDA 2022*a*). WS concluded that the use of lead ammunition is of low risk to the public and the environment and WS' use of lead ammunition is expected to continue to decline as non-lead ammunition continues to increase in availability and effectiveness and decrease in cost (USDA 2022*a*).

Recommendation of harvest during hunting and/or trapping seasons

When providing technical assistance, WS could recommend that people harvest or allow other people to harvest those mammal species with annual hunting seasons in Mississippi. However, in those cases, the entity experiencing damage, or the threat of damage would be responsible for implementing the recommendations made by WS' personnel; therefore, there would be no involvement by WS personnel.

Injection of euthanasia chemicals after live capture

WS' personnel would administer euthanizing chemicals to target animals by hand injection after personnel properly restrained and immobilized the animal. Because WS' personnel would identify the mammal species prior to administering euthanasia chemicals, the use of euthanasia chemicals would not adversely affect non-target animals. In addition, WS would appropriately dispose of carcasses following euthanasia, which would eliminate risks to non-target animals that may scavenge the carcass (see WS Directive 2.515).

Carbon dioxide for euthanasia

WS' personnel would administer carbon dioxide after placing a target animal inside a sealed chamber. Because WS' personnel would identify the mammal species prior to administering carbon dioxide, the use of carbon dioxide would not adversely affect non-target animals. In addition, WS would appropriately dispose of carcasses following euthanasia, which would eliminate risks to non-target animals that may scavenge the carcass (see WS Directive 2.515).

Gas Cartridges

WS' personnel would place gas cartridges inside burrow entrances and then seal the burrow. Before placing gas cartridges into the burrow entrance, WS' personnel would inspect the entrance for use by non-target animals prior to application. WS' personnel can identify active burrows by looking for fresh tracks and droppings at a burrow entrance with no spider webs and can distinguish burrows that non-target animals may use by looking for similar signs at the burrow entrance, such as looking for droppings and tracks of non-target animals. In addition, larger burrow entrances may indicate the presence of non-target animals using the burrow.

Because burrow systems would fill with carbon monoxide after placing gas cartridges into the burrow entrances and then sealing the entrances, WS expects carcasses of target mammals to remain underground. Carcasses that remain underground would generally not be available for scavenging by other animals unless the scavenger digs into the burrow system or den to find carcasses. Because target animals would succumb from the inhalation of carbon monoxide, secondary risks to scavengers would be minimal if carcasses occurred above ground or scavengers dug into a burrow system or den to retrieve carcasses. In addition, if WS' personnel found carcasses above ground during subsequent follow-up visits to the project area, WS' personnel would retrieve and dispose of those carcasses in accordance with WS Directive 2.515.

When using gas cartridges, WS' personnel would follow relevant label requirements to minimize risks to non-target species. When applicators follow the label directions, the use of sodium nitrate can be relatively target specific with minimal direct or secondary effects to other animals (Dolbeer et al. 1991, USDA 2019*h*). The primary threat would be directly to non-target animals that may be present in burrows, which WS' personnel can minimize by only treating burrows that woodchucks, coyotes, red fox, and striped skunks are actively using. The carbon monoxide trapped in burrows would eventually dissipate into the atmosphere and be diluted by the air.

Sodium nitrate and charcoal are the principle active chemicals in gas cartridges. Although stable under dry conditions, sodium nitrate is readily soluble in water and likely to be highly mobile in soils. In addition, dissolved nitrate is very mobile, moving quickly through the vadose zone to the underlying water table (USDA 2019*h*). However, burning sodium nitrate, as in the use of a gas cartridge as a fumigant in a den/burrow, likely produces mostly simple organic and inorganic gases, using all of the available sodium nitrate. The gas, along with other components of the cartridge, is likely to form oxides of nitrogen, carbon, phosphorus, and sulfur. Those products are environmentally non-persistent because soil microorganisms are likely to metabolize the oxides formed or they enter their respective elemental cycles. Gas cartridges consist of sodium nitrate, charcoal, fuller's earth, and borax. Sodium nitrate is not likely to accumulate in soils between applications, nor does it accumulate in the tissues of target animals (EPA 1991). In a human health and ecological risk assessment of WS' use of carbon monoxide, including carbon monoxide produced from sodium nitrate in gas cartridges, the risks to the environment were low (USDA 2019*h*).

Effects on non-target animal populations from unintentional take

As discussed previously, the potential effects on non-target animal populations associated with the use of non-lethal methods would be similar to those potential effects discussed for Alternative 2. Similarly, the potential effects associated with WS providing technical assistance would be similar to those potential effects discussed for Alternative 3. Of primary concern would be WS' use of lethal methods because those methods could result in the unintentional death of a non-target animal, which could potentially affect the populations of non-target animals.

However, WS does not anticipate the unintentional lethal removal of non-target animals to occur at such a frequency or intensity that would affect the population of a non-target species. WS would continue to monitor the activities conducted to ensure those activities or methodologies used in mammal damage management do not adversely affect the populations of non-target animals. While WS' personnel take precautions to safeguard against taking non-target animals during operational use of methods and techniques for resolving damage and reducing threats caused by mammals, the use of such methods could result in the incidental lethal removal of unintended species. The unintentional removal and capture of non-target species during damage management activities conducted under the proposed action/no action alternative (Alternative 1) would primarily be associated with the use of body-gripping traps and in some situations, with live-capture methods, such as foothold traps, cage traps, and cable devices.

From FY 2019 through FY 2023, WS' personnel lethally removed one Virginia opossum unintentionally during activities targeting mammal species addressed in this EA. WS could lethally remove additional species of non-target animals unintentionally; however, the removal of individuals from any species would not be likely to increase substantially above the number of non-target animals removed annually by WS during previous damage management activities. Similar to the analyses of lethal removal on the populations of target species addressed under Issue 1, of primary concern with the unintended removal of non-target animals is the magnitude of removal on those species' populations.

Those species lethally removed previously during activities targeting mammal species addressed in this EA are also target species in this EA and the level of removal analyzed for each of those species under Issue 1 included the unintentional removal that could occur by WS. Therefore, the analyses evaluated lethal removal of those species cumulatively under Issue 1, including removal that could occur when a species was a target or non-target. WS would continue to monitor activities, including non-target animal removal, to ensure the annual removal of non-target animals does not result in adverse effects to a species' population. In addition, hunters and/or trappers can harvest many of those species lethally removed as non-target animals previously by WS in the state during annual harvest seasons.

Methods available to resolve and prevent mammal damage or threats when employed by trained, knowledgeable personnel would be selective for target species. WS would report to the MDWFP any non-target animal removal to ensure removal by WS was considered as part of management objectives established for those species by the MDWFP. The potential for adverse effects to occur to the populations of non-target animals would be similar to the other alternative approaches, which would be extremely low based on previous non-target animal removal.

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

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

Analysis of risks to species designated as threatened or endangered pursuant to the Endangered Species Act

WS would make special efforts to avoid jeopardizing threatened or endangered species through biological evaluations of potential effects and the establishment of special restrictions or minimization measures through consultation with the USFWS and/or the National Marine Fisheries Service. The Endangered Species Act states that all federal agencies "...*shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act*" [Sec. 7(a)(1)]. WS conducts consultations with the USFWS and/or the National Marine Fisheries Services pursuant to Section 7 of the Endangered Species Act to ensure compliance. WS also conducts consultations to ensure that "*any action authorized, funded or carried out by such an agency...is not likely to jeopardize the continued existence of any endangered or threatened species…Each agency shall use the best scientific and commercial data available*" [Sec. 7(a)(2)].

During the development of this EA, WS reviewed the current list of species designated as threatened or endangered in Mississippi as determined by the USFWS and the National Marine Fisheries Service. WS conducted a review of potential impacts of implementing Alternative 1 on each of those species designated as threatened or endangered in the state by the USFWS (see Table D.1) and the National Marine Fisheries Service. The evaluation took into consideration the direct and indirect effects of implementing Alternative 1 to alleviate damage caused by mammals. WS reviewed the status, critical habitats designations, and current known locations of those species. As part of the review process, WS prepared and submitted a biological evaluation to the USFWS as part of the consultation process pursuant to Section 7 of the Endangered Species Act.

Based on the use pattern of the methods and the locations where WS could implement damage management activities, the implementation of Alternative 1 would have no effect on those threatened or endangered species in Mississippi under the jurisdiction of the National Marine Fisheries Service, including any designated critical habitat. In addition, based on the use patterns of methods currently available and based on current life history information for those species under the jurisdiction of the USFWS, WS determined that the proposed activities "*may affect*" those species but those effects would be solely beneficial, insignificant, or discountable, which would warrant a "*not likely to adversely affect*" determination. Based on those determinations, WS initiated informal consultation with the USFWS for those species that a "*may affect, not likely to adversely affect*" determination was made (see Table 1). The USFWS concurred with WS' determination that activities conducted pursuant to the proposed action would not likely adversely affect those species (J. Austin, USFWS, pers. comm. 2024).

Based on the locations where WS conducts activities to manage mammal damage and the use patterns of the methods available, WS has determined the proposed action alternative would not jeopardize the continued existence of the tricolored bat (*Perimyotis subflavus*), alligator snapping turtle (*Macrochelys temminckii*), Cumberland Moccasinshell (*Medionidus conradicus*), Tennessee pigtoe (*Pleuronaia barnesiana*), and monarch butterfly (*Danaus plexippus*).

WS would continue to abide by the following conditions when conducting activities to alleviate the damage that mammals cause in the state:

- Avoid working in ponds where dusky gopher frogs are known to occur, avoid working in streams with listed mussels, fish, or turtles, and avoid Mississippi sandhill crane nesting areas.
- When conducting ground-disturbing activities, the project site should be surveyed for potential roosting locations of threatened or endangered bat species, such as culverts, underpasses, caves, abandoned mines and buildings, wells, and snags. Because methods can disturb roosting bats offsite and result in abandonment of an area, activities should be conducted 500 yards away from any identified or potential roosting areas.
- In vegetated wetland areas, WS would conduct surveys for Mitchell's satyr butterflies, Price's potato bean, pondberry, and Louisiana quillwort, if suitable habitat were present.
- WS would survey forested areas with suitable habitat for red-cockaded woodpeckers.
- WS would survey areas with suitable soils and vegetation for gopher tortoises.

The USFWS has also designated critical habitat in Mississippi for some of the species listed as threatened or endangered. Table D.2 provides a list of those species with critical habitat designated in Mississippi or proposed to be designated along with WS' effects determination. WS has determined implementation of Alternative 1 would not destroy or adversely modify any critical habitat designated in Mississippi. WS based the effects determinations on a review of the activities that WS could conduct if WS implemented Alternative 1. The USFWS concurred with WS' effects determination for critical habitats designated in Mississippi (J. Austin, USFWS, pers. comm. 2024).

Table D.1 – List of threatened or endangered species in Mississippi and WS' effects determination

Common Name	Scientific Name	Status[†]	Determination[‡]
Animals			
Mammals			
Gray Bat	*Myotis grisescens*	E	MANLAA
Indiana Bat	*Myotis sodalist*	E	MANLAA
Northern Long-eared Bat	*Myotis septentrionalis*	E	MANLAA
Tricolored Bat	*Perimyotis subflavus*	PE	NJ
West Indian Manatee	*Trichechus manatus*	T	MANLAA
Birds			
Eastern Black Rail	*Laterallus jamaicensis* spp. *jamaicensis*	T	MANLAA
Mississippi Sandhill Crane	*Antigone canadensis pulla*	E	MANLAA
Piping Plover	*Charadrius melodus*	T	MANLAA
Red Knot	*Calidris canutus rufa*	T	MANLAA
Red-cockaded Woodpecker	*Picoides borealis*	E	MANLAA
Whooping Crane	*Grus americana*	EXPN	MANLAA
Reptiles			
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	E	MANLAA
Alligator Snapping Turtle	*Macrochelys temminckii*	PT	NJ
Black Pinesnake	*Pituophis melanoleucus lodingi*	T	MANLAA
Eastern Indigo Snake	*Drymarchon couperi*	T	MANLAA
Gopher Tortoise	*Gopherus polyphemus*	T	MANLAA

Green Sea Turtle	*Chelonia mydas*	T	MANLAA
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	MANLAA
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	MANLAA
Leatherback Sea Turtle	*Dermochelys coriacea*	E	MANLAA
Loggerhead Sea Turtle	*Caretta caretta*	T	MANLAA
Pearl River Map Turtle	*Graptemys pearlensis*	T	NE
Ringed Map Turtle	*Graptemys oculifera*	T	MANLAA
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	T	MANLAA
Amphibians			
Dusky Gopher Frog	*Rana sevosa*	E	MANLAA
Fishes			
Bayou Darter	*Etheostoma rubrum*	T	MANLAA
Gulf Sturgeon	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*	T	MANLAA
Pallid Sturgeon	*Scaphirhynchus albus*	E	MANLAA
Pearl Darter	*Percina aurora*	T	MANLAA
Clams			
Alabama Lampmussel	*Lampsilis virescens*	E	MANLAA
Alabama Moccasinshell	*Medionidus acutissimus*	T	MANLAA
Black Clubshell	*Pleurobema curtum*	E	MANLAA
Cumberland Moccasinshell	*Medionidus conradicus*	PE	NJ
Cumberlandian Combshell	*Epioblasma brevidens*	E	MANLAA
Fat Pocketbook	*Potamilus capax*	E	MANLAA
Heavy Pigtoe	*Pleurobema taitianum*	E	MANLAA
Inflated Heelsplitter	*Potamilus inflatus*	T	MANLAA
Longsolid	*Fusconaia subrotunda*	T	MANLAA
Orangenacre Mucket	*Hamiota perovalis*	T	MANLAA
Ovate Clubshell	*Pleurobema perovatum*	E	MANLAA
Oyster Mussel	*Epioblasma capsaeformis*	E	MANLAA
Pink Mucket	*Lampsilis abrupta*	E	MANLAA
Rabbitsfoot	*Quadrula cylindrica cylindrica*	T	MANLAA
Round Hickorynut	*Obovaria subrotunda*	T	MANLAA
Sheepnose Mussel	*Plethobasus cyphyus*	E	MANLAA
Slapside Pearlymussel	*Pleuronaia dolabelloides*	E	MANLAA
Snuffbox Mussel	*Epioblasma triquetra*	E	MANLAA
Southern Clubshell	*Pleurobema decisum*	E	MANLAA
Southern Combshell	*Epioblasma penita*	E	MANLAA
Tennessee Pigtoe	*Pleuronaia barnesiana*	PE	NJ
Insects			
Mitchell's Satyr Butterfly	*Neonympha mitchellii mitchellii*	E	MANLAA
Monarch Butterfly	*Danaus plexippus*	PT	NJ
Plants			
Flowering Plants			
Pondberry	*Lindera melissifolia*	E	MANLAA
Price's Potato-bean	*Apios priceana*	T	MANLAA
Tennessee Yellow-eyed Grass	*Xyris tennesseensis*	E	MANLAA
White Fringeless Orchid	*Platanthera integrilabia*	T	MANLAA
Whorled Sunflower	*Helianthus verticillatus*	E	MANLAA

Ferns and Allies			
Louisiana Quillwort	*Isoetes louisianensis*	E	MANLAA

†T=Threatened; E=Endangered; PT=Proposed Threatened; PE=Proposed Endangered; C=Candidate; EXPN=Experimental Population, Non-essential

‡NE=No effect; MANLAA=May affect, not likely to adversely affect; NJ=No Jeopardy

Since WS completed the consultation process with the USFWS, the USFWS has designated the Pearl River map turtle (*Graptemys pearlensis*) as a threatened species in Mississippi. The Pearl River map turtle inhabits rivers and large creeks that have sand and gravel bottoms and dense accumulations of deadwood within the Pearl River drainage from central Mississippi to the border of southern Mississippi and Louisiana. Pearl River map turtles are not associated with oxbow lakes and other floodplain habitats. During late spring and early summer, female Pearl River map turtles excavate nests on sandbars, and occasionally on steep cut-banks along riverbanks (see 89 FR 57206-57236). Based on the use pattern of available methods and the locations where WS conducts activities to manage mammal damage, WS has determined the proposed action alternative would have no effect on the status of the Pearl River map turtle. WS' activities to manage mammal damage would generally not occur within or along the rivers and large creeks of the Pearl River drainage. In addition, WS has not captured or lethally removed any turtle species during previous activities to manage damage caused by mammal species in Mississippi.

Table D.2 – Critical habitats designated in Mississippi

Common Name	Scientific Name	Status†	Determination‡
Animals			
Birds			
Mississippi Sandhill Crane	*Grus canadensis pulla*	CH	NE
Piping Plover	*Charadrius melodus*	CH	NE
Reptiles			
Black Pinesnake	*Pituophis melanoleucus lodingi*	CH	NE
Loggerhead Sea Turtle	*Caretta caretta*	CH	NE
Amphibians			
Dusky Gopher Frog	*Rana sevosa*	CH	NE
Fishes			
Gulf Sturgeon	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*	CH	NE
Pearl Darter	*Percina aurora*	CH	NE
Clams			
Alabama Moccasinshell	*Medionidus acutissimus*	CH	NE
Cumberlandian Combshell	*Epioblasma brevidens*	CH	NE
Louisiana Pigtoe	*Pleurobema riddellii*	PCH	NE
Orangenacre Mucket	*Hamiota perovalis*	CH	NE
Ovate Clubshell	*Pleurobema perovatum*	CH	NE
Oyster Mussel	*Epioblasma capsaeformis*	CH	NE
Rabbitsfoot	*Quadrula cylindrica cylindrica*	CH	NE
Round Hickorynut	*Obovaria subrotunda*	CH	NE
Slabside Pearlymussel	*Pleuronaia dolabelloides*	CH	NE
Southern Clubshell	*Pleurobema decisum*	CH	NE

†CH=Critical Habitat; PCH=Proposed Critical Habitat

‡NE=No destruction and no adverse modification

In addition, the USFWS has designated critical habitat in Mississippi for the pearl darter (*Percina aurora*). Based on a review of the proposed activities, implementation of Alternative 1 would not destroy and would not adversely modify any critical habitat designated for the pearl darter in Mississippi. The USFWS has designated approximately 524 river miles (843 river kilometers) in Clarke, Covington, Forrest, George, Green, Lauderdale, Jackson, Jones, Newton, Perry, Simpson, Stone, and Wayne Counties, Mississippi as critical habitat for the pearl darter.

The critical habitat consists of two units with Unit 1 consisting of connected river and stream channels within the Pascagoula River drainage system. Unit 1 consists of 63 river miles (102 kilometers) of the Pascagoula River channel from its confluence with the West Pascagoula River in Jackson County, upstream to the confluence of the Leaf and Chickasawhay Rivers in George County; 80 river miles (129 kilometers) of Big Black Creek/ Black Creek channel from its confluence with the Pascagoula River in Jackson County, upstream to U.S. Highway 49 Bridge in Forrest County; 160 river miles (257 kilometers) of Chickasawhay River channel from its confluence with the Leaf River just north of Enterprise, Clarke County, upstream to the confluence of Okatibbee Creek and Chunky River in Clarke County; 28 river miles (45 kilometers) of Chunky River channel from its confluence with Okatibbee Creek in Clarke County, upstream to the third (most upstream) Highway 80 Crossing in Newton County; 119 river miles (192 kilometers) of Leaf River channel from its confluence with the Chickasawhay River in George County, upstream to the bridge crossing at U.S. Highway 84 in Covington County; 15 river miles (24 kilometers) of Bouie River channel from its confluence with the Leaf River, upstream to the confluence of Okatoma Creek in Forrest County; and 28 river miles (45 kilometers) of Okatoma Creek from its confluence with the Bouie River in Forrest County, upstream to the bridge crossing at U.S. Highway 84 in Covington County. Unit 2 consists of 30 river miles (49 kilometers) of the Strong River channel from its confluence with the Pearl River, upstream to U.S. Highway 49, in Simpson County, Mississippi.

WS generally does not conduct activities to manage mammal damage within or on the large river systems where the pearl darter occurs. WS' use of methods to manage damage caused by mammal species would not result in the release of pollutants into aquatic environments and would not result in modification of any riverine habitat. Therefore, based on the use pattern of methods, WS has determined the proposed activities to manage mammal damage would not destroy or adversely modify any critical habitat designated for the pearl darter in Mississippi.

WS would continue to monitor the species designated by the USFWS and the National Marine Fisheries Service as threatened or endangered within the state, including any designated or proposed critical habitat, and would consult with the USFWS and/or the National Marine Fisheries Service pursuant to Section 7 of the Endangered Species Act, as appropriate. No take of threatened or endangered species by WS has occurred previously in the state during the implementation of activities and the use of methods to manage damage that mammals cause.

Analysis of risks to species designated as endangered by the MDWFP

Appendix F shows those species designated as endangered by the MDWFP within Mississippi. Based on the review of those species, WS has determined that the proposed activities would have no effect on those species currently listed as threatened or endangered by the MDWFP. WS would continue to review the species listed as endangered by the MDWFP and would consult with the MDWFP, as appropriate, when WS determines activities may adversely affect the populations of those species.

Potential effects to eagles from implementing Alternative 1

If WS implemented Alternative 1, WS would only conduct limited activities near active eagle nests and Important Eagle Use Areas in accordance with the National Bald Eagle Management Guidelines (USFWS 2007). The categories from the guidelines that would encompass most of these activities are Category D (off-road vehicle use), Category E (motorized watercraft use), Category F (non-motorized recreation and human entry), Category G (helicopters and fixed-wing aircraft), and Category H (blasting and other loud, intermittent noises). Those categories generally call for a buffer of 330 to 660 feet around active nests for Category D, Category E, and Category F activities, a 1,000 feet buffer around nests during the breeding season for Category G activities, and a half mile buffer for Category H activities. Although similar guidelines do not exist for golden eagles, WS would apply those guidelines when encountering golden eagles. WS does not expect the use of lethal and non-lethal methods to agitate or bother a bald eagle or golden eagle to a degree that causes, or is likely to cause, a decrease in its productivity or cause nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. WS based this determination on its adherence to the national bald eagle management guidelines (see USFWS 2007).

Alternative 2 – WS Would Manage Mammal Damage using an Adaptive Integrated Non-lethal Method Approach

Implementation of Alternative 2 would require WS to only recommend and use non-lethal methods to manage and prevent damage associated with mammals. WS would provide technical assistance and direct operational assistance by recommending and/or using only non-lethal methods. Using the WS Decision Model, WS' personnel would consider the potential effects to non-target animals from the use of non-lethal methods when formulating a management strategy. Non-lethal methods have the potential to cause adverse effects to non-target animals primarily through live-capture, exclusion, and dispersal.

If WS implemented Alternative 2, the possible negative physiological and/or behavioral effects that negative stimuli could cause are a concern, which could reduce the fitness of a non-target animal, or the ability of a non-target animal to survive, especially if exposure to the stressor were chronic. Stress caused during use of non-lethal methods could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs.

EFFECTS ON NON-TARGET ANIMAL POPULATIONS ASSOCIATED WITH IMPLEMENTING ALTERNATIVE 2

In general, the use of non-lethal methods to disperse, exclude, or capture target mammals from areas would have no effect on populations of non-target animals because those methods generally would not occur with such frequency or intensity to cause adverse effects. WS could occasionally capture non-target animals unintentionally when using live-capture traps, such as box traps. Because WS' personnel would check live-capture methods frequently, they could release non-target animals captured alive on site with minimal harm to the animal. Therefore, WS does not anticipate direct or indirect effects to occur to any non-target species. Based on the use pattern of methods and the activities that WS could conduct to manage damage or threats of damage caused by target mammal species, WS does not anticipate significant effects to occur to any non-target species. Activities conducted by WS would not occur with such frequency and would not occur at an intensity level that would cause cumulative adverse effects.

Risks to non-target animals associated with available non-lethal methods

Section I in Appendix C describes non-lethal methods that would be available for WS' personnel to use if WS implemented Alternative 2. Potential effects associated with specific methods, or a category of methods, occurs below.

Human presence

Human presence will include physical actions that WS could use to haze target species and consideration of WS' employees conducting activities to manage damage in Mississippi (*e.g.*, foot traffic around project sites or the use of vehicles to access locations). Like the intent of many non-lethal methods, the presence of people and/or a vehicle and the physical actions of clapping, waving, or yelling can disperse target species from an area through auditory and visual cues. Like many visual and auditory methods intended to disperse animals from a location, the primary concern would be the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal or the ability of a non-target animal to survive, especially if exposure to the stressor was chronic.

Activities conducted by WS can involve repeated visits to the same area until WS and/or another entity reduces damage or threats of damage. In some cases, such as airports, WS' employees may be present in areas multiple times a day and on a regular basis. However, like other visual and auditory stimuli, non-target animals often habituate to the presence of people, especially in areas where non-target animals frequently encounter people, such as urban areas. In addition, non-target animals are likely to return to the area once WS' personnel are no longer present. The presence of WS' personnel would not occur at a magnitude or intensity level that would cause harm to a non-target animal by preventing them from accessing essential resources (*e.g.*, food sources, habitat).

Modifying Cultural Practices

When providing technical assistance, WS could recommend that people requesting assistance modify behaviors that may be contributing to damage or threats of damage. However, in those cases, the entity experiencing damage or the threat of damage would be responsible for implementing the recommendations made by WS' personnel.

Limited Habitat Modification

WS could also recommend limited modification of habitat in some situations, such as pruning a tree near a residence to prevent raccoons from accessing the roof. In those cases, the entity experiencing damage or the threat of damage would be responsible for implementing the recommendations made by WS' personnel. WS' employees would recommend habitat modifications in limited circumstances where modifications could result in the dispersal of target animal species from an area or make an area less attractive to those species. WS' employees would not recommend habitat modifications over large areas and would not recommend modifications to the extent that would result in the removal or modification of large areas of habitat. The use of habitat modifications would generally be restricted to urban areas, airports, industrial parks, office complexes, and other areas where human activities are high.

Supplemental Feeding

Providing a supplemental food source and/or planting and maintaining lure crops could be methods that WS recommends to entities experiencing damage or the threat of damage. Similar to other recommendations that WS could make when providing technical assistance, the entity requesting assistance would be primarily responsible for providing a supplemental food source and/or planting and maintaining lure crops. WS' employees would not recommend the use of supplemental feeding or the use of lure crops over large areas and would not recommend modifying habitat to plant lure crops to the extent that would result in the removal or modification of large areas of habitat. The use of lure crops is likely to occur in areas already modified for agriculture production.

Exclusion methods

Any exclusionary device erected to prevent access of target species also potentially excludes species that were not the primary reason for erecting the exclusion. Most scenarios that involve the use of exclusion devices would occur in areas heavily modified by people and are not areas that threatened or endangered species generally use. In addition, WS' personnel and other entities would not employ exclusionary devices over large geographical areas or use those devices at such an intensity level that essential resources (*e.g*., food sources, habitat) would be unavailable. Given the locations where WS could use or recommend exclusion devices, their use would not restrict movement of threatened or endangered species from habitat or restrict those species from accessing a food source. The use of predator exclosures around nests of ground nesting birds could reduce predation risks, which could benefit a ground nesting bird species.

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, Isaksson et al. 2007). Therefore, the use of exclosures should be carefully evaluated prior to use (Smith et al. 2011).

Visual Scaring Techniques

Several visual scaring methods would be available for WS' personnel to recommend and/or use to manage damage. The intent associated with the use of visual dispersal methods is to elicit a flight response by scaring target animals from an area where damage is occurring or where damage could occur. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal, or the ability of a non-target animal to survive, especially if the exposure to the stressor was chronic. The stress from dispersal methods could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs. However, for effects to occur, a non-target animal would have to encounter a visual dispersal method and the resulting visual stimuli would have to elicit a negative response. Like auditory stimuli, non-target animals often habituate to the use of visual scaring techniques, especially in areas where non-target animals frequently encounter people, such as urban areas. In addition, non-target animals are likely to return to the area once WS' personnel are no longer using those methods. The use of visual scaring techniques would not occur at a magnitude or intensity level that would cause harm to a non-target animal by preventing them from accessing essential resources (*e.g.*, food sources, habitat).

Auditory Deterrents

Like the use of visual dispersal methods, the intent with the use of auditory dispersal methods, such as electronic hazing devices, pyrotechnics, and propane cannons, is to illicit a flight response in target animals by mimicking distress calls, producing a novel noise, or producing an adverse noise. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal, or the ability of a non-target animal to survive, especially if the exposure to the stressor was chronic. The stress from dispersal methods could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs. However, for effects to occur, a non-target animal would have to be within hearing distance at the time WS' personnel used an auditory method and the resulting noise stimuli would have to elicit a negative response. Like visual stimuli, non-target animals often habituate to the use of auditory deterrents, especially in areas where non-target animals frequently encounter people, such as urban areas. In addition, non-target animals are likely to return to the area once WS' personnel are no longer using those methods. The use of auditory deterrents would not occur at a magnitude or intensity level that would cause harm to a non-target animal by preventing them from accessing essential resources (*e.g.*, food sources, habitat).

Paintballs, rubber bullets, bean bags, and similar non-lethal methods

As described on product labeling and Safety Data Sheets, paintballs are non-toxic to people and do not pose an environmental hazard. However, consumption may cause toxicosis in dogs, which is potentially fatal without supportive veterinary treatment (Donaldson 2003). Although unknown, Donaldson (2003) speculated there is an osmotic diuretic effect resulting in an abnormal electrolyte and fluid balance in dogs that consume paintballs. Most affected dogs recovered within 24 hours (Donaldson 2003).

The effects associated with the use of rubber bullets, bean bags, and similar non-lethal methods would be similar to those described for the use of firearms because the noise associated with using those methods would be similar to the noise produced when using a firearm.

Trained Dogs

WS could use and/or recommend the use of trained dogs to locate certain target species, such as feral swine. WS would only use trained dogs that are responsive to their handler. For tracking and trailing dogs, WS would only use dogs trained to follow the scent of the target species. WS' personnel could call the dog off the track should the employee determine the dog is following the scent of a non-target species because WS would only use trained dogs that are responsive to their handler. Like other dispersal methods, the use of trained dogs can elicit a flight response because the target animals perceive the dog as a predator. Like other dispersal methods, of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of a non-target animal, or the ability of a non-target animal to survive, especially if the exposure to the stressor was chronic. However, for effects to occur, a non-target animal would have to be present while a dog was present, and the resulting stimuli would have to elicit a negative response. Like visual and auditory stimuli, non-target animals are likely to return to the area once WS' personnel are no longer using trained dogs. The use of trained dogs would not occur at a magnitude or intensity level that would cause harm to a non-target animal by preventing them from accessing essential resources (*e.g.*, food sources, habitat).

Guard Animals

WS could recommend the use of guard animals when providing technical assistance. Therefore, WS would not be directly involved with using guard animals.

Nets

Nets could include the use of net guns, cannon/rocket nets, drop nets, hand nets, and throw nets. Nets would restrain animals once captured and are live-capture methods. Nets have the potential to capture non-target species. However, the use of nets would essentially be selective for target species because WS' personnel would identify the target animals prior to application. Net placement in areas where target species are active, and the use of target-specific attractants would likely minimize the capture of non-target animals. WS' personnel would attend nets appropriately, which would allow them to release any non-target animals captured unharmed or to only activate the net when non-target animals are not present.

Even though live capture does occur from those methods, the potential for death of a target or non-target animal while being restrained or released does exist, primarily from being struck by cannon or rocket assemblies during deployment. The likelihood of cannon or rocket assemblies striking a non-target animal is extremely low. The risk is likely extremely low because a non-target animal must be present when WS' personnel activate the net, and the non-target animal must be in a position where the assemblies strike the animal. WS' personnel would position nets so the net envelops target animals upon deployment, which would minimize the risk of assemblies striking a non-target animal. When using nets, WS' personnel would often use a bait to attract target species and to concentrate target species in a specific area to ensure the net completely envelopes target animals. Therefore, WS' personnel could abandon sites if non-target animal use of the area were high or could refrain from firing the net at a time when non-target animals were present. The noise associated with firing cannon/rocket nets and net guns would be similar to those described for auditory deterrents.

Injuries to animals do occur from the use of nets. Injuries to deer occurred when using drop nets with the rate of injury being correlated with the number of deer captured during a single application of the net (Haulton et al. 2001). Non-target animals incidentally captured can be released on site unharmed. For more information on nets and WS' use of nets, see USDA (2020).

Denning

Before digging out a coyote or fox den, WS' personnel would confirm that coyotes or fox were using the den (*e.g.*, viewing target animals at the den site, observing tracks). Burrows of gopher tortoises have a distinctive half-moon shape that WS' personnel can easily identify. This would allow WS' personnel to avoid excavating gopher tortoise burrows. Denning would only occur when young may be present inside a den. WS would not excavate dens with signs of non-target animal activity. WS does not frequently use denning in Mississippi.

Hand Capture and Catch Poles

The use of hand capture methods is essentially selective for target species because WS' personnel would identify target animals prior to application. WS' personnel would use catch poles to restrain animals. Thus, WS' personnel would be able to accurately identify any animal before application of catch poles. Thus, WS does not anticipate direct or indirect effects to occur to non-target animals from the use of hand capture methods.

Cage-type Traps, Corral Traps, Net Traps, and Culvert Traps

Cage-traps, corral traps, net traps, and culvert traps are available in a variety of designs, but they operate similarly. Cage-traps, corral traps, net traps, and culvert traps are mechanical methods that live-capture animals and are not methods that would contaminate water or result in the bioaccumulation of chemicals or other hazardous materials. Hazards to animals captured in cage traps include stress, injury, and death. For example, White et al. (1991) demonstrated that red fox held in cage traps of a box-style had elevated levels of the stress hormones, adrenocorticotropin and cortisol, as well as other physiological impacts when compared to fox not held in cages. Some animals may struggle to escape, and they may become injured. Blundell et al. (1999) reported swelling and abrasions to appendages of river otter live captured in Hancock traps and serious damage to teeth, presumably from otters chewing on the metal to escape. Powell and Proulx (2003) reported abrasions to the muzzles of animals live-captured in cage traps. Mowat et al. (1994) noted injuries to lynx (*Lynx lynx*) that were live captured in box traps that ranged from broken or split claws to superficial cuts on the nose, and rarely on the face. Mowat et al. (1994) considered those injuries to lynx that occurred from capture in box traps to be minor. Of the non-target animals live-captured in box traps during a study conducted by Mowat et al. (1994), only one fox suffered injury from a cut on the foot, which was considered minor.

Death of captured animals could occur because of environmental conditions, such as extreme temperatures or exposure to rain. Euthanasia of animals could be necessary when release was improper due to a trap related injury. Cage traps generally allow the safe release of non-target species and result in a lower potential for stress and injury compared to other trapping methods

(Mowat et al. 1994, Powell and Proulx 2003, Kolbe et al. 2003, Schutz et al. 2006, Iossa et al. 2007, Munoz-Igualada et al. 2008).

Mortality rates associated with cage traps are low and impacts to a species population are not anticipated from cage trapping efforts (Gosling et al 1988, Baker et al. 2001, Way et al. 2002, Short et al. 2002, Shivik et al. 2005, Iossa et al. 2007). Risks of capturing non-target animals and mortality rates would be dependent on the target animal and ability to implement cage trapping measures that are species specific reducing non-target captures. WS implementing measures that increase selectivity and reduce capture time minimize the risk to non-target animals. For example, the adoption and advancement of electronic signaling devices have been shown to reduce the holding time for trapped animals reducing the potential for stress and other impacts to non-target animals (Larkin et al. 2003, Benevides et al. 2008, Darrow and Shivik 2008, Will et al. 2010). Signals sent from traps to remote devices such as cell phones not only serve to reduce the holding time for captured animals but also allow personnel to collect more accurate data regarding trapping, ensure compliance with regulations regarding trap monitoring and address animal welfare concerns. The use of the appropriate cage trap size and design; trap placement; and the selection of bait or lure applicable to the target animal reduce the risk of the capture of non-target species (Baker and Clarke 1988, Andrzejewski and Owadowska 1994, Jojola et al. 2009, Phillips and Winchell 2011).

Live traps have the potential to capture non-target species if those non-target species enter inside the trap or trigger a trap. In addition, animals may become entangled in net traps. The placement of live traps in areas where target species are active, and the use of target-specific attractants would likely minimize the capture of non-target animals. WS' personnel would attend live traps appropriately, which would allow them to release any non-target animals captured unharmed in most situations.

Foothold traps

WS would primarily use foothold traps to capture larger predatory mammal species, such as coyotes, fox, bobcats, and feral dogs. When setting foothold traps in the ground, personnel dig a shallow depression in the ground that is slightly larger than the trap being set. The depression is generally prepared just deep enough so, when placing the trap in the depression, the pan of the trap is at or just below the soil surface. Typically, the trap attaches to an anchoring stake or stakes by a chain. Personnel drive the anchoring stake or stakes into the depression to hold the trap. Generally, once placing the anchoring stake or stakes in the depression, personnel sift loose dirt into the depression, and they then press the set trap into the bottom of the depression to ensure the trap does not wobble. Personnel generally place a pan cover over the pan to prevent objects from getting under the pan and preventing it from depressing when a target animal applies pressure. After placing the pan cover, personnel sift loose dirt over the top of the trap to conceal the trap. When using foothold traps, personnel generally make a dirt-hole set, cubby set, or flat set.

Dirt-hole sets generally consist of a small hole dug into an embankment, the base of a plant, or other natural feature. The hole slants back about six to eight inches deep into the embankment or under the backing. Personnel then place the foothold trap, as described previously, so the center of the trap is approximately seven inches from the hole for fox and 12 inches back from the hole for coyotes. Often, personnel will place bait or lure at the back of the hole, so the target animal triggers the trap when they step in front of the hole to investigate. When using bait, personnel often obscure the entrance to the hole with grass or other light debris to prevent raptors from seeing the bait from the air. Cubby sets are similar to a dirt-hole set except instead of digging a hole in dirt, personnel create a "*hole*" using rocks or other debris with only one entrance. Personnel place the bait or lure inside the "*hole*" and place the trap in front of the entrance. As a target animal approaches to investigate the bait or lure in the "*hole*", they trigger the trap. Personnel generally use cubby sets for smaller predator species, such as raccoons and bobcats.

A flat set is similar to a dirt-hole set but personnel do not dig a hole to place bait or lure in. In place of the hole, personnel use a chunk of wood, old bone, or other visual attractor to get the attention of the target animal. Personnel then place a few drops of lure or squirt coyote urine (or urine of another target species) on the attractor. Personnel then place the foothold trap, as described previously, in front of the attractor approximately six inches.

Personnel can minimize the risk of capturing non-target animals by the selection of trap size for the target animal, use of pan-tension devices, selection of the proper bait, lure or attractant, and appropriate trap placement. Selecting the proper trap size can reduce the risk of catching animals larger than the target species because they can pull free if the trap is activated. Pan-tension devices reduce the risk of capturing animals that weigh less than target animals. Turkowski et al. (1984) reported non-target exclusion efficiency rates of 92, 95, and 100% for shear-pin, leaf spring, and steel tape tension devices, respectively compared to 6% for the standard trap set for coyotes. Kamler et al. (2000) used pan-tension devices to show a reduced rate of non-target captures in foothold traps designed to trap coyotes and bobcats. Non-target captures were greatest for raccoons that had body weights in the range for the target species and would not be feasible to exclude from trapping.

Kamler et al. (2002) reported 100% exclusion for the swift fox and skunk in padded traps using a pan-tension device while trapping coyotes. Kamler et al. (2008) reported an exclusion efficiency of 93% for non-target animals using soft-catch foothold traps and pan-tension devices while still providing effective trapping efficiencies for the black backed jackal (*Canis mesomelas*). Therefore, the use of baits, lures, and attractants that are preferred by the target species can minimize the chances of capture of non-target species. The attractant allows for more targeted management of animals and will reduce the potential for trapping non-target animals. The home ranges, habitat preferences, travel corridors, population densities of both target and non-target species are considered when selecting locations for the placement of foothold traps. Similar to body-grip traps and cage traps, lures and attractants would not be substances that would bioaccumulate in the environment and those attractants would not cause environmental harm.

Enclosed Foothold Traps

The enclosed foothold trap is designed to target animals that are capable of reaching inside the narrow entrance of the trap (normally 1.5 inches in diameter) to push or pull the trigger, which reduces the risk of non-target animals from being captured, such as dogs or coyotes. The triggers are generally recessed 2 to 3 inches inside the trap, which excludes many animals from reaching inside the narrow entrance and pulling or pushing the trigger, which limits risks to other non-target animals.

Translocation

Generally, WS would not translocate mammal species, except for black bears. Translocation would only occur with prior authorization from the MDWFP. If authorized by the MDWFP, WS would release animals in habitat appropriate for the species. WS would not translocate non-native species. In addition, WS would only release mammals after the property owner and/or manager gave WS permission to release the animal or animals on their property or properties. WS does not anticipate translocating and releasing mammals with any frequency or intensity that would result in direct or indirect effects to non-target species.

Unmanned Aerial Vehicles

WS' personnel could use UAVs to inspect areas where target species are causing damage, collect images or videos to compare before and after removal efforts have been conducted, or locate target species. Of concern are the possible negative physiological and/or behavioral effects that negative stimuli could cause, which could reduce the fitness of non-target animals, or the ability of non-target animals to survive, especially if the exposure to the stressor was chronic. The stress from dispersal methods could negatively affect the health of an animal, interfere with the raising of young, and/or increase energy needs. However, for effects to occur non-target animals would have to visually encounter UAVs or their shadows and/or be within hearing distance at the time WS' personnel used UAVs and the resulting visual and/or auditory stimuli would have to elicit a negative response. Like other non-lethal methods, WS' personnel would not employ UAVs over large geographical areas or use UAVs at such an intensity level that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over such a wide geographical scope that long-term adverse effects would occur to a species' population.

Aerial Operations

Aircraft play an important role in the management of various wildlife species for many agencies. Resource management agencies rely on low flying aircraft to monitor the status of many animal populations, including large mammals (Lancia et al. 2000), birds of prey (Fuller and Mosher 1987), waterfowl (USFWS 2024), and colonial waterbirds (Speich 1986). Low-level flights also occur when entities use aircraft to track animal movements by radio telemetry (Gilmer et al. 1981, Samuel and Fuller 1996). Aerial operations could be an important method for surveying, monitoring, and tracking animals in Mississippi. WS could also use aerial shooting to lethally remove large mammal species, such as feral swine and coyotes. Low-level flights, including the use of UAVs, have the potential to disturb wildlife. Some species will frequently or at least occasionally show an adverse response to even minor overflights.

A number of studies have looked at responses of various wildlife species to aircraft overflights. The National Park Service (1995) reviewed the effects of aircraft overflights on wildlife and suggested that adverse effects could occur to certain species. Few, if any studies, have proven that aircraft overflights cause adverse impacts to wildlife populations, although the National Park Service (1995) stated it is possible to draw the conclusion that affects to populations could occur. The effects on wildlife from military-type aircraft have been studied extensively (Air National

Guard 1997) and were found to have no expected adverse effects on wildlife. In general, the greatest potential for impacts to occur exists when overflights are frequent, such as hourly and over many days that could represent "*chronic*" exposure. Chronic exposure situations generally involve areas near commercial airports and military flight training facilities. Even then, many wildlife species often habituate to overflights, which would naturally minimize any potential adverse effects where such flights occur on a regular basis.

Examples of species or species groups that have been studied with regard to the issue of aircraft-generated disturbance are as follows:

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

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

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

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

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

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

Passerines: Reproductive losses have been reported in one study of small territorial passerines ("*perching*" birds that included sparrows, blackbirds) after exposure to low altitude overflights (see Manci et al. 1988 as cited in Air National Guard 1997), but natural mortality rates of both adults and young are high and variable for most species. The research review indicated passerine birds cannot be driven any great distance from a favored food source by a non-specific disturbance, such as military aircraft noise, which indicated quieter noise would have even less effect. Passerines avoid intermittent or unpredictable sources of disturbance more than predictable ones but return rapidly to feed or roost once the disturbance ceases (Gladwin et al. 1988, United States Forest Service 1992). In a study comparing the impacts of aircraft noise on bird vocalizations, Vincelette et al. (2021) found that bird vocalizations increased after aircraft flew over an area but an increase in alarm calls may have caused the increase in vocalization. Vincelette et al. (2021) also found the noise of aircraft did not influence the vocal activity of birds in an area where aircraft overflights were prevalent. Those studies and reviews indicated there is little or no potential for aerial operations to cause adverse effects on passerine bird species.

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

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

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

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

Although many of those animal species discussed above are not present in Mississippi, the information was provided to demonstrate the relative tolerance most animal species have of overflights, even those that involve noise at high decibels, such as from military aircraft. WS has used aircraft and helicopters in areas inhabited by wildlife throughout the United States for many years. WS would only conduct aerial shooting on areas where the appropriate property owner has signed a work initiation document allowing WS to conduct activities on their property. In addition, WS often concentrates efforts during certain times of the year (*e.g.*, fall and winter when less vegetation increases ground visibility) and to specific areas. WS flies very little over any one property under agreement in any given year. As a result, no known problems to date have occurred with WS' aerial shooting overflights on wildlife, nor are they anticipated in the future. As with any aerial operations, the WS program aircraft-use policy helps ensure that aerial surveys would be conducted in a safe and environmentally sound manner, in accordance with federal and state laws. Pilots and aircraft must also be certified under established WS program procedures and policies.

Aerial operations conducted by WS rarely occur in the same areas on a daily basis, and aircraft used by WS actually spend little time flying over those particular areas. The fact that WS would only conduct aerial shooting, aerial surveying, and aerial telemetry on a very small percentage of the land area of Mississippi indicates that most animals would not even be exposed to aerial overflights in Mississippi. Further lessening the potential for any adverse effects is that such flights occur infrequently throughout the year. Therefore, aircraft used by WS should have far less potential to cause any disturbance to wildlife than military aircraft because the military aircraft produce much louder noise and would be flown over certain training areas many more times per year, and yet were found to have no expected adverse effects on wildlife (Air National Guard 1997). Aerial operations conducted by WS rarely occur in the same areas on a daily basis, and aircraft used by WS actually spend little time flying over those particular areas.

Scout Animals

Because live capture of mammals using other methods would occur prior to the application of radio and/or GPS transmitters, WS' personnel would identify target mammal species prior to the use of Judas animals. WS would only release Judas animals in areas where those animals already occur. Thus, WS does not anticipate direct or indirect effects to occur to non-target animals from the use of this method.

GonaCon™

In a human safety and environmental risk assessment of WS' use of GonaCon™, USDA (2022*b*) determined that ecological risks from the use of GonaCon™ were negligible based on how the product is applied, its environmental fate, and label requirements. GnRH is rapidly metabolized once injected into a white-tailed deer and has a short half-life (less than one hour), which reduces the risk of a non-target animal or organism ingesting GnRH if the treated deer dies after treatment.

The label requires applicators make every attempt to recover all darts if applicators use remote delivery systems. Darts may fall out of or miss target animals and remain on the ground if applicators fail to locate and remove them. Darts impacting the deer should inject the contents into the animal; therefore, darts that fall off of target animals should contain negligible to no GnRH. If misses occur, the impact with the ground or another object is likely to evacuate the contents into the soil or onto the object. If a miss occurred and the impact did not evacuate the

GnRH from the dart, non-target animals would have to ingest the dart to be exposed to GnRH. Applicators that use darts would be knowledgeable in the use of the remote delivery systems and would receive training in the proficient use of those systems to minimize the likelihood of a miss occurring (USDA 2022*b*). During the registration process with the EPA, the EPA granted waivers for environmental fate studies and waived the need for aquatic and terrestrial ecological effects data because, when applicators use GonaCon™ according to label instructions, there is limited potential for environmental release (EPA 2009, USDA 2022*b*).

Exposure of non-target wildlife to GonaCon™ could occur primarily from secondary hazards associated with wildlife consuming deer that have been injected with GonaCon™. Several factors inherent with GonaCon™ reduce risks to non-target wildlife from direct consumption of deer injected with the vaccine (EPA 2009, USDA 2022*b*). The vaccine itself and the antibodies produced by deer in response to the vaccine are both proteins, which if consumed, would be broken down by stomach acids and enzymes (EPA 2009, USDA 2010*b*, USDA 2022*b*). The EPA determined that the potential risks to non-target wildlife from the vaccine and the antibodies produced by deer in response to the vaccine "*...are not expected to exceed the Agency's concern levels*" (EPA 2009).

Immobilizing drugs

WS could administer chemicals (*e.g*., Telazol, Ketamine) to immobilize mammals in certain instances (*e.g*., affixing a radio and/or GPS transmitter on an animal to be used as a scout animal, transport to other locations). In most situations, WS would first capture the target animal using live-capture methods (*e.g*., live-capture traps, nets). After live-capture, WS' personnel would administer immobilizing drugs through hand injection or jab stick. WS could also administer immobilization chemicals to target species through injection using a projectile (*e.g*., dart gun).

Similar to the use of firearms, using projectiles to administer immobilization drugs is essentially selective for target mammals because WS' personnel would identify target species prior to application. There is a slight risk of misidentifying target species, especially when target and non-target species have a similar appearance. There is also a slight risk of unintentionally administering immobilization chemicals to non-target animals if a projectile strikes a non-target animal if misses occur. WS' personnel can minimize risks by using appropriate projectiles, by being aware of what is near or beyond the target animal, and by training to be proficient with the use of a projectiles (*e.g*., dart guns). Therefore, risks to non-target species from the use of immobilization chemicals are very low and would not result in adverse impacts on non-target species' populations. If misses occurred during the use of projectiles to administer immobilizing chemicals, WS would make reasonable attempts to retrieve any projectiles.

Animals anesthetized using immobilizing drugs recover once the animal has fully metabolized the drug. Therefore, non-target animals that may consume animals that recover are unlikely to receive a dosage that would cause any impairment. When using immobilizing drugs to handle or transport target animals, WS would monitor anesthetized animals until that animal recovers sufficiently to leave the site.

Repellents

Repellents available to manage damage caused by mammals are usually products the EPA has classified as general use pesticides, which means the public can purchase and use those products without the need for a pesticide applicators license. By definition, general use pesticides are those products the EPA has determined would not generally cause unreasonable adverse effects on the environment when applicators use those products pursuant to the label. People generally apply taste repellents directly to affected resources, which elicits an adverse taste or texture response when the target animal ingests the treated resource or the ingestion of the repellent causes temporary sickness (*e.g.*, nausea). Products containing coyote urine or other odors associated with predatory wildlife are intended to elicit a fright response in target wildlife by imitating the presence of a predatory animal (*i.e.*, wildlife tend to avoid areas where predators are known to be present). If repellents are available for use in Mississippi to reduce damage caused by mammals, WS could employ or recommend for use those repellents that were available. WS anticipates using repellents infrequently. However, repellents are not likely to adversely affect populations of non-target animals.

The active ingredients in many commercially available repellents are naturally occurring substances (*e.g.*, capsaicin, whole egg solids), which are substances often used in food preparation (EPA 2001). When used according to label instructions, most repellents would be safe because 1) they are not toxic to animals, if ingested; 2) there is normally little to no contact between animals and the active ingredient, and 3) the active ingredients are found in the environment and degrade quickly (EPA 2001). Therefore, the use and recommendation of repellents would not have negative impacts on non-target species when used according to label requirements. Most repellents for mammals pose a very low risk to non-target animals when exposed to or when ingested.

Attractants

Lures and food attractants are sometimes used to encourage target animals to enter inside traps or to trigger traps; however, relatively small quantities are used, and those items are not considered hazardous. Food attractants consist of food items that are preferred by target animals. Therefore, lures and attractants would not be substances that would bioaccumulate in the environment and those attractants would not cause environmental harm.

Potential effects to eagles from implementing Alternative 2

If WS implemented Alternative 2, WS would only conduct limited activities near active eagle nests and Important Eagle Use Areas in accordance with the National Bald Eagle Management Guidelines (USFWS 2007). WS does not expect the use of non-lethal methods to agitate or bother a bald eagle or golden eagle to a degree that causes, or is likely to cause, a decrease in its productivity or cause nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. WS based this determination on its adherence to the national bald eagle management guidelines (see USFWS 2007).

Alternative 3 – WS would recommend an integrated methods approach to managing mammal damage in Mississippi through technical assistance only

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

The only methods that would have limited availability for use by the public would be immobilizing drugs, euthanasia chemicals, aerial activities, and GonaCon™. Immobilizing drugs, euthanasia chemicals, aerial activities, and GonaCon™ would generally not be available for use by the public but other professionals could use those methods or people could use other methods to achieve the same results.

The potential impacts to non-target animals under this alternative would be variable and based on several factors. If people employed methods as recommended by WS, the potential impacts to non-target animals would likely be similar to Alternative 1. If people provided technical assistance did not use the recommended methods and techniques correctly or people used methods that WS did not recommend, the potential impacts on non-target species, including T&E species, would likely be higher when compared to Alternative 1.

The potential impacts of hazing and exclusion methods on non-target species would be similar to those described for Alternative 2. Hazing and exclusion methods would be easily obtainable and simple to employ. Because identification of targets would occur when employing shooting as a method, the potential impacts to non-target species would likely be low under this alternative. However, the knowledge and experience of the person could influence their ability to distinguish between similar mammal species correctly.

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

If WS provided technical assistance to people but those people did not implement any of the recommended actions and conducted no further action, the potential to remove non-target animals would be lower when compared to Alternative 1. If those persons requesting assistance implemented recommended methods appropriately and as instructed or demonstrated, the potential impacts to non-target animals would be similar to Alternative 1. If WS made recommendations on the use of methods to alleviate damage but people did not implement those methods recommended by WS or if people used those methods recommended by WS inappropriately, the potential for lethal removal of non-target animals would likely increase under a technical assistance only alternative. Therefore, the potential impacts to non-target animals, including T&E species, would be variable under a technical assistance only alternative. It is possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal killing of mammals, which could lead to unknown effects on local non-target species populations, including some T&E species.

When the damage caused by wildlife reaches a level where assistance does not adequately reduce damage or where no assistance is available, people sometimes resort to using chemical toxicants that are illegal for use on the intended target species and often results in loss of both target and non-target wildlife (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015). The use of illegal toxicants by individuals frustrated with the lack of assistance or assistance that inadequately reduces damage to an acceptable level can often result in the indiscriminate take of wildlife species.

People requesting assistance are likely to use lethal methods because a damage threshold has been met for that person that has triggered them to seek assistance to reduce damage. The potential impacts on non-target animals by those persons experiencing damage would be highly variable. People whose mammal damage problems that were not effectively resolved by non-lethal control methods would likely resort to other means of legal or illegal lethal control. This could result in less experienced persons implementing control methods and could lead to greater take of non-target wildlife than the proposed action.

WS' recommendation that mammals be harvested during the regulated season by private entities to alleviate damage would not increase risks to non-target animals. Shooting would essentially be selective for target species and the unintentional lethal removal of non-target animals would not likely increase based on WS' recommendation of the method.

The ability to reduce negative effects caused by mammals to wildlife species and their habitats, including T&E species, would be variable under this alternative. The skills and abilities of the person implementing damage management actions would determine the risks to non-target animals.

Alternative 4 – WS would not provide any assistance with managing damage caused by mammals in Mississippi

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

The ability to reduce damage and threats of damage caused by mammals would be variable based upon the skills and abilities of the person implementing damage management actions under this alternative. The risks to non-target animals and T&E species would be similar across the alternative approaches because most of those methods described in Appendix C would be available to use by people if WS implements this alternative. If people apply those methods available as intended, risks to non-target animals would be minimal to non-existent. If people apply those methods available incorrectly or without knowledge of animal behavior, risks to non-target animals could be higher if WS implements this alternative. If frustration from the lack of available assistance causes those persons experiencing mammal damage to use methods that are not legally available for use, risks to non-target animals could be higher if WS implements this alternative. People have resorted to the use of illegal methods to resolve wildlife damage that have resulted in the lethal take of non-target animals (*e.g.*, see Allen et al. 1996, United States Department of Justice 2014, United States Department of Justice 2015).

APPENDIX E. RISKS TO HUMAN HEALTH AND SAFETY ASSOCIATED WITH AVAILABLE METHODS

When providing direct operational assistance, WS' personnel would assess the damage or threat occurring, evaluate the management methods available, and formulate a management strategy to alleviate damage or reduce the risk of damage. A WS' employee would formulate a management strategy by selecting from those methods described in Appendix C that the employee determines to be practical for use. WS' employees who conduct activities to alleviate mammal damage would be knowledgeable in the use of methods, the wildlife species responsible for causing damage or threats, and WS' Directives. WS' personnel would incorporate that knowledge into the decision-making process inherent with the WS' Decision Model, which they would apply when addressing threats and damage caused by mammals. Therefore, when evaluating management methods and formulating a management strategy for each request for assistance, WS' employees would consider risks to human health and safety associated with methods.

For example, WS' personnel would consider the location where activities could occur. Risks to human safety from the use of methods would likely be greater in highly populated urban areas in comparison to rural areas that are less densely populated. If WS' personnel conducted activities on rural private property, where the property owner or manager could control and monitor access to the property, the risks to human safety from the use of methods would likely be lower. If damage management activities occurred at or near public use areas, then risks of the public encountering damage management methods and the corresponding risk to human safety would increase. In general, WS' personnel would conduct activities when human activities were minimal (*e.g.*, early mornings, at night) or in areas where human activity was minimal (*e.g.*, in areas with restricted public access).

WS' personnel receive training in the safe use of methods and would follow the safety and health guidelines required by WS' directives (*e.g.*, see WS Directive 2.401, WS Directive 2.430, WS Directive 2.450, WS Directive 2.465, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.626, WS Directive 2.627, WS Directive 2.635, WS Directive 2.640). Before providing direct operational assistance, WS and the entity requesting assistance would sign a work initiation document that would indicate the methods the cooperating entity agrees to allow WS to use on the property they own or property they manage. Thus, the cooperating entity would be aware of the methods that WS could use on property they own or manage, which would help identify any risks to human safety associated with the use of those methods. WS' personnel would also make the cooperator requesting assistance aware of threats to human safety associated with the use of methods.

As allowed by law, WS' personnel would provide information about food safety and the safe handling of carcasses to reduce risks to landowners that prefer to retain feral swine carcasses or other animal carcass killed on their property for personal use (see WS Directive 2.510). Therefore, providing information about food safety and the safe handling of carcasses would minimize risks to human safety by emphasizing precautions for safe handling and preparation/consumption. In addition, WS' personnel would recommend that landowners avoid feeding uncooked meat or other carcass products to pets or other animals.

Risks to human health and safety associated with WS' use of non-lethal methods occurs in Section I below with risks associated with lethal methods discussed in Section II below.

I. RISKS TO HUMAN HEALTH AND SAFETY ASSOCIATED WITH NON-LETHAL METHODS

WS discusses below the risks to human health and safety for each of the non-lethal methods that WS could use to manage mammal damage in Mississippi. No adverse effects to human health and safety have occurred from WS' use of non-lethal methods to alleviate mammal damage in the state from FY 2019 through FY 2023. Based on the use patterns of non-lethal methods available to address damage caused by mammals and for those reasons discussed for the individual methods below, the risks to human health and safety would be low when used appropriately and by trained personnel. Therefore, WS does not expect any direct or indirect effects to occur from WS' use of those non-lethal methods.

Human presence

WS' activities would comply with relevant laws, regulations, policies, orders, and procedures. WS' personnel would follow the safety and health guidelines required by WS' directives (*e.g.*, see WS Directive 2.401, WS Directive 2.430, WS Directive 2.435, WS Directive 2.450, WS Directive 2.465, WS Directive 2.605, WS Directive 2.615, WS Directive 2.620, WS Directive 2.626, WS Directive 2.627, WS Directive 2.630, WS Directive 2.635, WS Directive 2.640). Therefore, the physical actions of WS' employees, including the presence of employees and vehicles would not pose threats to human health and safety.

Modifying Cultural Practices, Limited Habitat Modification, and Supplemental Feeding

The recommendation by WS that a property owner or manager modify cultural practices, use habitat manipulation methods, and/or a supplemental feeding program to reduce damage or threats of damage caused by target species would not increase risks to human safety above those risks already inherent with a property owner or manager conducting similar activities on their property. Recommendations to modify cultural practices, use habitat manipulation methods, and/or supplemental feeding on property owned or managed by a cooperator to reduce localized target species populations that could then reduce target species damage or threats would not increase risks to human safety. Although accidents do occur when using certain equipment required to perform habitat manipulation and/or supplemental feeding (*e.g.*, the use of tractors, chainsaws, or other specialized equipment), the recommendation of using habitat manipulation methods and/or supplemental feeding to reduce localized target species populations would not increase those risks.

Structural changes and exclusion methods

WS could recommend structural changes when providing technical assistance. Therefore, other entities would be responsible for making structural changes or incorporating ways to reduce risks of mammal damage when designing structures. Exclusion methods would prevent mammals from accessing a resource, such as placing hardware cloth around a tree to prevent beaver from gnawing on the tree. Based on their use profile for alleviating damage associated with mammals, WS considers risks to human safety associated with structural changes and exclusion methods to be low.

Visual Scaring Techniques

Visual deterrents that WS' personnel could use and/or recommend would include electronic guards (siren strobe-light devices), lasers, lights, scarecrows, human effigies, effigies of predators, flags, and fladry. Lasers and lights would pose minimal risks to the public because application occurs directly to target species by trained personnel, which limits the exposure of the public to misuse of the method. Similarly, the use of electronic guards and effigies would not pose risks to human safety.

Auditory Deterrents

Auditory deterrents that WS could use and/or recommend would include electronic hazing devices, pyrotechnics, and propane cannons. Risks to human health and safety would primarily occur from the noise produced by those methods, such as hearing loss from repeated and/or prolonged exposure to the noise produced by those methods. Other risks could include fire risks and bodily harm associated with the use of pyrotechnics and propane cannons. Although hazards to human safety from the use of auditory deterrents do occur, those methods are generally safe when used by trained individuals who have experience in their use. For example, although some risk of fire and bodily harm exists from the use of pyrotechnics, when used appropriately and in consideration of those risks, WS' personnel can use those methods with a high degree of safety. WS' employees would adhere to safety requirements and use appropriate personal protective equipment pursuant to WS Directive 2.605. WS' personnel who use pyrotechnics would follow the guidelines for using pyrotechnics in accordance with WS Directive 2.627.

Paintballs, rubber bullets, bean bags, and similar non-lethal methods

As described on product labeling and Safety Data Sheets, paintballs are non-toxic to people and do not pose an environmental hazard. Similar to WS' use of firearms, would consider risk to public safety before determining that use of paintballs, rubber bullets, bean bags, and similar non-lethal methods were appropriate. When used in consideration of human safety, risks associated with the use of paintballs, rubber bullets, bean bags, and similar non-lethal methods would be low.

Trained Dogs

WS could use and/or recommend the use of trained dogs to locate target animals, such as feral swine, in areas where they are causing damage or posing a threat of damage. WS would only use trained dogs that are responsive to their handler, which would minimize risks to the public. WS' use of trained dogs would adhere to WS Directive 2.445. The potential risks to human health and safety and the environment from the use of trained dogs would be negligible (USDA 2021).

Guard Animals

WS could provide recommendations on guard animals through technical assistance. Therefore, WS would not be directly involved with the use of guard animals. The property owner or manager would be responsible for guard animals.

Nets

WS typically uses nets in areas where human activity is minimal to ensure public safety. People could become entangled in nets if present during use. There could be a risk of cannon or rocket assemblies striking a person during deployment. The likelihood of cannon or rocket assemblies striking a person is extremely low. The risk is likely extremely low because WS' personnel would be present on site during the use of nets and can address any safety concerns. WS evaluated the potential human health and environmental risks from WS' proposed use of nets and determined that the risks to human health and the environment are negligible for both WS staff and the general population (USDA 2020).

Denning

Denning would not pose risks to human health and safety because denning only involves excavating a den using a shovel or similar hand tools. Some risks to WS' personnel would occur from excavating the den, primarily through muscle strains and similar injuries; however, those would likely be minor.

Hand Capture and Catch Poles

Risks to human health and safety from use of hand capture is mostly limited to potential bites to WS personnel that are directly handling the targeted animal. WS' employees receive training to handle captured animals with hand methods and tools; therefore, risks to human safety are low (USDA 2023*a*).

Mechanical Live-capture Methods

Live-capture methods that would be available for WS' personnel to use and/or recommend would include hand capture, catch poles, hand nets, throw nets, drop nets, net guns, cannon/rocket nets, cage-type traps, non-lethal cable devices, and foothold traps. Live-capture methods are typically used in situations where human activity would be minimal to ensure public safety. Traps rarely cause serious injury because live-capture traps available for target species are typically walk-in style traps where target species enter but are unable to exit or require a target species to trigger the trap. Therefore, human safety concerns associated with live traps and cable devices used to capture target species require direct contact to cause bodily harm. If left undisturbed, risks to human safety would be minimal. Other live-capture devices, such as cannon/rocket nets, pose minor safety hazards to the public because activation of the device occurs by trained personnel that are present on site and personnel would only activate the method after they observe target species in the capture area of the net. Personnel employing cannon/rocket nets are present at the site during application to ensure the safety of the public and operators.

Although some fire and explosive hazards exist with cannon/rocket nets during ignition and storage of the explosive charges, safety precautions associated with the use of the method, when adhered to, pose minimal risks to human safety and primarily occur to the handler. WS would not use cannon/rocket nets in areas where public activity was high, which further reduces the risks to the public. WS would use nets in areas with restricted public access whenever possible to reduce risks to human safety. WS' personnel employing hand nets, throw nets, drop nets, cannon/rocket nets, and net guns would also be present at the site during application to ensure the safety of the public. Through programmatic risk assessments, WS has determined the use of foothold traps (USDA 2019*f*), cage traps (USDA 2019*d*), cable devices (USDA 2019*e*), and nets (USDA 2020) to manage wildlife damage pose minimal risks to the human health and safety.

Translocation

After using live-capture methods to capture target species, WS could translocate an animal to appropriate habitat for release. Release sites would likely be remote areas and released animals are not likely to pose a threat to human safety except for those personnel involved with transporting and releasing the animal. WS' personnel would take appropriate precautions to minimize risks when releasing animals.

Unmanned Aerial Vehicles

When using UAVs, WS' personnel would adhere to all federal, state, and local laws. All WS' personnel who use UAVs are required to have a commercial Remote Pilot Certificate from the Federal Aviation Administration. To help ensure safe use and awareness, WS' employees who use UAVs receive training from an approved UAV training course and to remain certified to use UAVs, WS' employees must operate an UAV every 90 days to maintain proficiency. WS' personnel who use UAVs are also required to follow the guidelines established in the WS' Small Unmanned Aircraft System Flight Operations Procedures manual. When using UAVs, there would be a minimum of two WS' personnel present: a Pilot-in-Command, who is remotely controlling the UAV, and a Visual Observer, who alerts the Pilot-in-Command of any dangers while the UAV is being flown. The UAV must always remain in the visual line-of-sight of either the Pilot-in-Command and/or the Visual Observer. Additionally, UAVs are not to be operated over any person that is not directly involved with flight operations. By following the safety precautions outlined by the WS' Small Unmanned Aircraft System Flight Operations Procedures manual, UAVs pose minimal risks to human safety.

Aerial Operations

Like any other flying, aerial wildlife operations, such as aerial shooting, aerial surveying, and aerial telemetry, may result in an accident. WS' employees participating in any aspect of aerial operations would receive training and certification in their role and responsibilities during operations. All WS' personnel involved in aerial operations would follow the policies and directives set forth in WS' Directive 2.620; WS' Aviation Operations Manual; WS' Aviation Safety Manual and its amendments; Title 14 CFR; and Federal Aviation Regulations, Part 43, 61, 91, 119, 133, 135, and 137. Furthermore, WS' pilots and crewmembers would be trained and experienced to recognize the circumstances that lead to accidents. The national WS Aviation Program has increased its emphasis on safety, including funding for additional training, the establishment of a WS Flight Training Center, and annual recurring training for all pilots. Still, accidents may occur, and the environmental consequences should be evaluated.

Nationwide, the WS program has been using aircraft during aerial operations for many years. During this time, no incidents of major ground fires associated with WS' aircraft accidents have occurred; thus, the risk of catastrophic ground fires caused by an aircraft accident is exceedingly low. Aviation fuel is generally extremely volatile and will evaporate within a few hours or less. The fuel capacity for aircraft used by WS varies. For fixed-winged aircraft, a 52-gallon capacity would generally be the maximum, while 91 gallons would generally be the maximum fuel capacity for helicopters. In some cases, little or none of the fuel would be spilled if an accident occurs. Thus, there should be little environmental hazard from unignited fuel spills.

With the size of aircraft used by WS, the quantities of oil (*e.g.*, 6 to 8 quarts maximum for reciprocating (piston) engines and 3 to 5 quarts for turbine engines) capable of being spilled in any accident would be small with minimal chance of causing environmental damage. Aircraft used by WS would be single engine models, so the greatest amount of oil that could be spilled in one accident would be about eight quarts. When exposed to oxygen, petroleum products biodegrade through volatilization and bacterial action (EPA 2000). Thus, small quantity oil spills on surface soils can be expected to biodegrade readily. Even in subsurface contamination situations involving underground storage facilities that would generally be expected to involve larger quantities than would ever be involved in a small aircraft accident, the EPA guidelines provide for "*natural attenuation*" or volatilization and biodegradation in some situations to mitigate environmental hazards (EPA 2000). Thus, even where oil spills in small aircraft accidents were not cleaned up, the oil does not persist in the environment or persists in such small quantities that no adverse effects would be expected. In addition, WS' accidents generally would occur in remote areas away from human habitation and drinking water supplies. Thus, the risk to drinking water appears to be exceedingly low to nonexistent.

For these reasons, the risk of ground fires or fuel/oil pollution from aviation accidents would be low. In addition, based on the history and experience of the program in aircraft accidents, it appears the risk of significant environmental damage from such accidents is exceedingly low. Through programmatic risk assessments, WS has determined the use of aircraft during activities to manage wildlife damage pose a low risk to human health and safety (USDA 2019*c*).

Scout Animals

After using live-capture methods to capture target species and using immobilization chemicals to sedate target species, WS could attach radio and/or GPS transmitters to those target animals before releasing the animal at the site of capture. The use of Judas animals would not pose a risk to the public. WS' personnel would wear gloves and other personal protective equipment to minimize the risks associated with handling target animals while attaching transmitters. Therefore, the use of Judas animals would not pose a risk to human health and safety.

GonaCon™

WS would follow applicable label requirements when handling and administering GonaCon™, including applicable requirements for personal protective equipment. GonaCon™ is pre-packaged in syringes, which reduces exposure risks associated with withdrawing GonaCon™ from a vile with a syringe. In addition, GonaCon™ is administered through hand injection or remote delivery, which further reduces exposure risks. The active ingredient of GonaCon™ is rapidly metabolized and has a short half-life (less than an hour) so ingestion of the active ingredient from treated animals that people may harvest and consume is unlikely. If WS uses remote delivery, the label requires WS to make every attempt to recover all darts, which would minimize risks of the public finding a dart. WS evaluated the potential human health and ecological risks from the proposed use of GonaCon™ and determined that the risks to human health and the environment are negligible (USDA 2022*b*).

Immobilizing drugs

WS could administer chemicals (*e.g.*, Telazol, Ketamine, or a mixture of Ketamine and Xylazine) to immobilize mammals in certain instances (*e.g.*, affixing a radio and/or GPS transmitter on an animal). For WS' personnel to administer immobilization drugs to a target animal, the animal would first need to be captured using live-capture methods (*e.g.*, suitcase-type trap). All WS' personnel who handle and administer immobilization drugs would be properly trained in the use of those methods. WS' employees would follow approved procedures outlined in WS' Immobilization and Euthanasia Manual (see WS Directive 2.430). Training and adherence to agency directives would ensure the safety of employees applying immobilization drugs. Immobilizing drugs used by WS would be securely stored and properly monitored to ensure the safety of the public. WS anticipates using immobilizing drugs infrequently and only in limited situations, such as to translocate Louisiana black bears. WS Directive 2.430 outlines WS' acquisition, storage, and use of immobilizing drugs. WS has conducted a programmatic risk assessment to determine risks to human health and the environment. Based on the use patterns of immobilizing drugs and WS adherence to WS Directive 2.430, risks to human health and safety would be low (USDA 2024*b*).

Repellents

WS could recommend and/or use repellents registered for use to disperse target species causing damage or threats of damage. Repellents are typically used in situations where human activity would be minimal to ensure public safety. All WS' personnel who handle and administer repellents would be properly trained in the use of those methods. Training and adherence to WS' directives would ensure the safety of employees applying repellents. WS' involvement, either through recommending the use of repellents or the direct use of repellents, would ensure that label requirements of those repellents are discussed with those persons requesting assistance when recommended through technical assistance or would be specifically adhered to by WS' personnel when using repellents. Repellents, when used according to label directions, are generally regarded as safe, especially when the ingredients are considered naturally occurring. Some risk of exposure to the chemical would occur to the applicator, as well as others, as the product was applied due to the potential for drift. Some repellents also have restrictions on whether application can occur on edible plants with some restricting harvest for a designated period after application. All restrictions on harvest and required personal protective equipment would be included on the label and if followed, would minimize risks to human safety associated with the use of those products. Through a programmatic risk assessment WS has determined that the risks to human safety associated with the use of repellents would be extremely low (USDA 2024*a*).

Attractants

Lures and food attractants are sometimes used to encourage target animals to enter inside traps or to trigger traps; however, relatively small quantities are used and those items are not considered hazardous. Food attractants consist of food items that are preferred by target animals. Lures could include liquid attractants that mimic another target animal. Therefore, lures and attractants would not be substances that would bioaccumulate in the environment and those attractants would pose risks to human health and safety.

Meat Donation for Human Consumption

Under the proposed action/no action alternative (Alternative 1), WS could donate meat from white-tailed deer lethally removed during damage management activities to charitable organizations for human consumption (see WS Directive 2.510). WS in Mississippi would only donate meat from white-tailed deer under the proposed action alternative. In addition to exposure to lead exposure, there is potential for the spreading of zoonotic diseases and exposure to harmful chemicals in deer processed and donated for human consumption. If WS donated white-tailed deer for human consumption, WS' personnel would follow WS' policies pertaining to the testing or labeling of meat in order to address potential health concerns. The testing of deer donated for exposure to substances such as organophosphate and carbamate insecticides, mercury, arsenic, organochlorines, and organic chemicals could occur prior to distribution for human consumption. WS would not donate deer immobilized using immobilizing drugs or euthanized using euthanasia chemicals for human consumption. WS would dispose of carcasses of deer euthanized with euthanasia chemicals pursuant to WS Directive 2.515. Deer removed by any method for disease sampling or in an area where zoonotic diseases of concern were known to be prevalent and of concern to human health after consuming processed deer meat would not be donated for consumption and would be disposed of by deep burial or incineration. WS' adherence to policy would not result in adverse effects to human health from the donation of deer meat.

II. RISKS TO HUMAN HEALTH AND SAFETY ASSOCIATED WITH LETHAL METHODS

WS discusses below the risks to human health and safety for each of the lethal methods that WS could use to manage mammal damage in Mississippi. No adverse effects to human health and safety have occurred from WS' use of lethal methods to alleviate mammal damage in the state from FY 2019 through FY 2023. Based on the use patterns of lethal methods available to address damage caused by mammals and for those reasons discussed for the individual methods below, the risks to human health and safety would be low when used appropriately and by trained personnel. Therefore, WS does not expect any direct or indirect effects to occur from WS' use of those lethal methods.

Body-grip traps

WS typically uses body-grip traps in areas where human activity is minimal to ensure public safety. Body-grip traps rarely cause serious injury to people because they only trigger through direct activation of the device. Threats to human health and safety associated with body-grip traps vary with trap size and the type of trap. Injuries could range from cuts, bruises, or abrasions on fingers and hands to broken or fractured bones if a person accidently triggered the trap or was unfamiliar with the trap and attempted to handle the trap. In extreme scenarios, a person could drown if a body-grip trap closes on both hands and the person falls into deeper water, especially if the person was wearing hip or chest waders, which is common when setting body-grip traps in water sets.

Risks of injury would primarily be associated with WS' employees setting, checking, and handling body-grip traps. Risks to the public would primarily occur to people that tamper with or unknowingly encounter a body-grip trap. The property owner or manager would be aware of the types of methods that WS could use on the property or properties they own or manage by signing a work initiation document that includes those methods they agree to allow WS to use on their property. Pursuant to WS Directive 2.450, WS' employees must post appropriate warning signs on the main entrances or commonly used access points to areas where employees are using body-grip traps. In addition, WS' personnel that use body-grip traps with a jaw spread greater than eight inches must use those traps in water sets (*i.e.*, partially or completely submerged in water) unless a State Director approves exemptions on a case-by-case basis. Body-grip traps are passive, mechanical methods that, if left undisturbed, would pose a minimal risk to the public. However, if people intentionally tamper with or unknowingly step on or in a quick-kill trap, depending on the style, injuries could occur. WS would also use body-grip traps in compliance with applicable federal, state, and local laws and regulations (see WS Directive 2.210), as well as WS' directives to minimize risks to human health and safety. WS evaluated the potential human health and environmental risks associated with the use of quick-kill traps, including body-gripping traps, and found the risks to be low (USDA 2022*c*).

Cable devices

WS typically uses cable devices in areas where human activity is minimal to ensure public safety. Cable devices rarely cause serious injury to people because they only trigger through direct activation of the device. Injuries could range from cuts, bruises, or abrasions on fingers, hands, arms, feet, and legs to minor cuts to hands and fingers from broken strands of cable or frayed cable ends. Risks of injury would primarily be associated with WS' employees setting, checking, and handling cable devices. Risks to the public would primarily occur to people that tamper with or unknowingly encounter a cable device (USDA 2019*e*).

The property owner or manager would be aware of the types of methods that WS could use on the property or properties they own or manage by signing a work initiation document that includes those methods they agree to allow WS to use on their property. Pursuant to WS

Directive 2.450, WS' employees must post appropriate warning signs on the main entrances or commonly used access points to areas where employees are using cable devices. Cable devices are passive, mechanical methods that, if left undisturbed, would pose a minimal risk to the public. However, if people intentionally tamper with or unknowingly step on or in a cable device, depending on the style, injuries could occur. WS would also use cable devices in compliance with applicable federal, state, and local laws and regulations (see WS Directive 2.210), as well as WS' directives to minimize risks to human health and safety. WS evaluated the potential human health and environmental risks associated with the use of cable devices and found the risks to be low (USDA 2019*e*).

Firearms

Certain safety issues can arise related to misusing firearms and the potential human hazards associated with the use of firearms to reduce damage and threats of damage. All WS' personnel who use firearms would follow the guidelines in WS Directive 2.615. To help ensure safe use and awareness, WS' employees who use firearms to conduct official duties receive training from an approved firearm safety-training course, and to remain certified for firearm use, WS' employees must attend a re-certification safety-training course in accordance with WS Directive 2.615. In addition, WS' employees who use firearms from an aircraft must receive training and certification to do so, and to remain certified for firearm use from an aircraft, WS' employees must attend a re-certification safety-training course in accordance with WS Directive 2.615. WS' employees who carry and use firearms as a condition of employment are subject to the Lautenberg Domestic Confiscation Law and are required to inform their supervisor if they can no longer comply with the Lautenberg Domestic Confiscation Law (see WS Directive 2.615). WS would work closely with cooperators requesting assistance to ensure that WS' personnel consider all safety issues before deeming the use of firearms to be appropriate.

The use of firearms to alleviate damage caused by target species would be available if WS implements any of the alternative approaches unless otherwise prohibited by the MDWFP and/or other governmental entity, or under the Airborne Hunting Act (16 USC 742j-1). The Airborne Hunting Act prohibits using a firearm from an aircraft to lethally shoot wildlife. However, an entity may obtain a license or permit issued by a state agency (*e.g.*, the MDWFP) to use firearms fired from an aircraft to lethally remove wildlife. Thus, other entities may conduct aerial shooting operations, provided they obtain appropriate licenses or permits. Because the use of firearms to alleviate damage caused by target species would be available under any of the alternative approaches and the use of firearms by those persons experiencing damage caused by target species could occur whether they contacted or consulted WS, the risks to human safety from the use of firearms would be similar among all the alternative approaches.

If WS' personnel use firearms to remove target species lethally, WS would retrieve the carcasses to the extent possible. WS' personnel would dispose of the carcasses retrieved in accordance with WS Directive 2.515 and would comply with requirements in permits and/or authorizations issued by the MDWFP for activities associated with target species. Through programmatic risk assessments, WS has determined the use of firearms to manage wildlife damage pose a low risk to human health and safety (USDA 2019*g*).

There are also several aviation-related human safety issues that are associated with aerial shooting. The aviation-related safety issues associated with aerial shooting would be the same as those risks associated with conducting other aerial operations (*e.g.*, aerial surveying, aerial telemetry). Therefore, to reduce redundancy, the safety of WS' use of aircraft occurs below in the discussion for aerial operations.

Lead Ammunition

The environmental fate of lead once it degrades suggests the small amounts of lead that may end up in the environment because of WS' activities would not have adverse impacts on soil, air, and water quality (USDA 2022*a*). There could be a concern associated with WS' use of lead ammunition and the consumption of white-tailed deer meat donated to a charitable organization after WS lethally removed the deer using a firearm. The concern would be for lead fragments from ammunition that could be present in the deer meat processed for human consumption. Under the proposed action/no action alternative (Alternative 1), WS could donate meat from white-tailed deer lethally removed during damage management activities to charitable organizations for human consumption (see WS Directive 2.510). WS in Mississippi would only donate meat from white-tailed deer under the proposed action alternative. WS could recommend the donation white-tailed deer meat under the technical assistance only alternative (Alternative 3), but WS' personnel would not provide direct operational assistance under the technical assistance only alternative.

Regularly eating meat from wildlife harvested with lead ammunition, especially animals harvested with highly fragmented bullets may cause increases in blood lead levels compared to background levels, particularly in children (Johansen 2004, Hunt 2009, Kosnett 2009, Tranel and Kimmel 2009, Pain et al. 2010). In most cases, WS donates white-tailed deer that employees lethally removed by a shot to the head or neck, which reduces the likelihood of harvesting meat for consumption that contains lead fragments. Stewart and Veverka (2011) documented that white-tailed deer shot with lead ammunition in the head or extreme upper neck in sharpshooting situations showed no deposition of lead fragments in the meat of the animals that people would process for human consumption. Lower neck shots do frequently experience lead fragmentation in the loin muscle and Stewart and Veverka (2011) recommended removing the loins prior to processing to ensure that people did not ingest the fragments. WS only donates meat processed professionally or by the recipient and hematomas (*i.e.*, areas of tissue where pools of mostly clotted blood form) associated with areas of bullet penetration tend to be cut out to avoid lead fragments and foul-tasting meat.

WS' personnel would receive training to shoot and target the head and upper neck of white-tailed deer when removing deer that may be donated for human consumption. WS would not donate any deer shot in the lower neck or would process those deer to avoid the areas that could contain lead fragments. Overall, the training of WS personnel (*e.g.*, shot placement) and the awareness of potential lead contamination in meat donated (*e.g.*, avoiding harvesting meat where lead fragments are likely to occur) minimizes the risk of WS' use lead ammunition. WS carcass disposal policy (see WS Directive 2.515) further reduces the risk of lead exposure (USDA 2022*a*). In a risk assessment, USDA (2022*a*) concluded the potential of lead toxicity from WS' use of lead ammunition, especially to children who are the most sensitive to the effects of lead, would be negligible.

Recommendation of harvest during hunting and/or trapping seasons

The recommendation by WS that a property owner or manager allow people to harvest target species during the annual hunting and/or trappings seasons would not increase risks to human safety above those risks already inherent with hunting and trapping target species. Recommendations of allowing hunting and/or trapping on property owned or managed by a cooperator to reduce a localized target species population that could then reduce damage or threats caused by target species would not increase risks to human safety. Safety requirements established by the MDWFP for annual hunting and trapping seasons would further minimize risks associated with those activities. Although hunting and trapping accidents do occur, the recommendation of allowing hunting and/or trapping to reduce localized populations of target species would not increase those risks.

Injection of euthanasia chemicals after live capture

WS could administer chemicals to euthanize mammals in certain instances. WS' personnel would only administer euthanasia chemicals to a target animal after capturing the animal using live capture methods and only after the animal was properly immobilized. All WS' personnel who handle and administer euthanasia chemicals would be properly trained in the use of those methods. WS' employees would follow approved procedures outlined in the WS' Field Manual for the Operational Use of Immobilizing and Euthanizing Drugs (USDA 2019*b*). Training and adherence to agency directives would ensure the safety of employees applying euthanasia chemicals. All chemicals used by WS would be securely stored and properly monitored to ensure the safety of the public. WS Directive 2.430 outlines WS' use of euthanasia chemicals and training requirements to use those chemicals. After using euthanasia chemicals, WS' employees would dispose of carcasses in accordance with WS Directive 2.515. Based on the use patterns of euthanasia chemicals and those reasons listed above, the risks to human health and safety are extremely low.

Carbon dioxide for euthanasia

Risks to human health and safety from WS use of carbon dioxide inside a sealed chamber would primarily occur to the applicator. The carbon dioxide released into the sealed chamber would diffuse into the atmosphere once WS personnel opened the chamber to dispose of the animal. The use of carbon dioxide for euthanasia would occur in ventilated areas where exposure of the applicator or the public to large concentrations of released carbon dioxide would not occur. Therefore, the risks to human safety from WS' use of carbon dioxide for euthanasia are extremely low.

Gas Cartridges

When using gas cartridges containing sodium nitrate and charcoal, WS' personnel would also locate and plug all entrances to the den except the entrance selected for treatment. WS' personnel would then use a nail to puncture a hole into the fuse-end cap of the gas cartridge to insert the fuse as directed by the label. WS' personnel would hold the cartridge away from their face and body and then light the fuse. WS' employees would place the gas cartridge, fuse-end first, as far into the den as possible and then seal the den entrance immediately with soil. If smoke escapes through cracks in the ground, WS' personnel would cover the cracks with additional soil. The fuse will ignite the sodium nitrate, which produces carbon monoxide gas when burned. At high concentrations, carbon monoxide gas is highly toxic to wildlife and people.

Because WS' personnel would seal den entrances to trap the carbon monoxide gas inside the den, target animals are likely to succumb to the effects of the carbon monoxide gas underground (Matschke and Fagerstone 1984). Therefore, carcasses of target animals are not likely to be available above ground for scavenging or handling by the public.

Carbon monoxide can be hazardous to people, especially when present in high concentrations within confined spaces. WS' personnel would follow the applicable label requirements for the use of sodium nitrate to manage damage caused by target animals, including those that minimize risks to human safety.

The carbon monoxide trapped in dens would eventually dissipate into the atmosphere and be diluted by the air (EPA 1991). WS' personnel would be present on site when conducting activities and can prevent people from accessing areas while conducting activities to minimize risks to the public. In addition, WS could conduct activities during times when the public are not present (*e.g.*, early morning). Therefore, minimal risks to human safety would occur from the use of sodium nitrate. In human health and ecological risk assessments of WS' use of carbon monoxide, the risks to human and safety were low (USDA 2019*h*).

APPENDIX F. THREATENED AND ENDANGERED SPECIES

List of threatened or endangered species in Mississippi and WS' effects determination

Common Name	Scientific Name	Status †	Determination ‡
Animals			
Mammals			
Gray Bat	*Myotis grisescens*	E	MANLAA
Indiana Bat	*Myotis sodalist*	E	MANLAA
Northern Long-eared Bat	*Myotis septentrionalis*	E	MANLAA
Tricolored Bat	*Perimyotis subflavus*	PE	NJ
West Indian Manatee	*Trichechus manatus*	T	MANLAA
Birds			
Eastern Black Rail	*Laterallus jamaicensis* spp. *jamaicensis*	T	MANLAA
Mississippi Sandhill Crane	*Antigone canadensis pulla*	E	MANLAA
Piping Plover	*Charadrius melodus*	T	MANLAA
Red Knot	*Calidris canutus rufa*	T	MANLAA
Red-cockaded Woodpecker	*Picoides borealis*	E	MANLAA
Whooping Crane	*Grus americana*	EXPN	MANLAA
Reptiles			
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	E	MANLAA
Alligator Snapping Turtle	*Macrochelys temminckii*	PT	NJ
Black Pinesnake	*Pituophis melanoleucus lodingi*	T	MANLAA
Eastern Indigo Snake	*Drymarchon couperi*	T	MANLAA
Gopher Tortoise	*Gopherus polyphemus*	T	MANLAA
Green Sea Turtle	*Chelonia mydas*	T	MANLAA
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	MANLAA
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	MANLAA

Leatherback Sea Turtle	*Dermochelys coriacea*	E	MANLAA
Loggerhead Sea Turtle	*Caretta caretta*	T	MANLAA
Pearl River Map Turtle	*Graptemys pearlensis*	T	NE
Ringed Map Turtle	*Graptemys oculifera*	T	MANLAA
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	T	MANLAA
Amphibians			
Dusky Gopher Frog	*Rana sevosa*	E	MANLAA
Fishes			
Bayou Darter	*Etheostoma rubrum*	T	MANLAA
Gulf Sturgeon	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*	T	MANLAA
Pallid Sturgeon	*Scaphirhynchus albus*	E	MANLAA
Pearl Darter	*Percina aurora*	T	MANLAA
Clams			
Alabama Lampmussel	*Lampsilis virescens*	E	MANLAA
Alabama Moccasinshell	*Medionidus acutissimus*	T	MANLAA
Black Clubshell	*Pleurobema curtum*	E	MANLAA
Cumberland Moccasinshell	*Medionidus conradicus*	PE	NJ
Cumberlandian Combshell	*Epioblasma brevidens*	E	MANLAA
Fat Pocketbook	*Potamilus capax*	E	MANLAA
Heavy Pigtoe	*Pleurobema taitianum*	E	MANLAA
Inflated Heelsplitter	*Potamilus inflatus*	T	MANLAA
Longsolid	*Fusconaia subrotunda*	T	MANLAA
Orangenacre Mucket	*Hamiota perovalis*	T	MANLAA
Ovate Clubshell	*Pleurobema perovatum*	E	MANLAA
Oyster Mussel	*Epioblasma capsaeformis*	E	MANLAA
Pink Mucket	*Lampsilis abrupta*	E	MANLAA
Rabbitsfoot	*Quadrula cylindrica cylindrica*	T	MANLAA

Round Hickorynut	*Obovaria subrotunda*	T	MANLAA
Sheepnose Mussel	*Plethobasus cyphyus*	E	MANLAA
Slapside Pearlymussel	*Pleuronaia dolabelloides*	E	MANLAA
Snuffbox Mussel	*Epioblasma triquetra*	E	MANLAA
Southern Clubshell	*Pleurobema decisum*	E	MANLAA
Southern Combshell	*Epioblasma penita*	E	MANLAA
Tennessee Pigtoe	*Pleuronaia barnesiana*	PE	NJ
Insects			
Mitchell's Satyr Butterfly	*Neonympha mitchellii mitchellii*	E	MANLAA
Monarch Butterfly	*Danaus plexippus*	PT	NJ
Plants			
Flowering Plants			
Pondberry	*Lindera melissifolia*	E	MANLAA
Price's Potato-bean	*Apios priceana*	T	MANLAA
Tennessee Yellow-eyed Grass	*Xyris tennesseensis*	E	MANLAA
White Fringeless Orchid	*Platanthera integrilabia*	T	MANLAA
Whorled Sunflower	*Helianthus verticillatus*	E	MANLAA
Ferns and Allies			
Louisiana Quillwort	*Isoetes louisianensis*	E	MANLAA

†T=Threatened; E=Endangered; PT=Proposed Threatened; PE=Proposed Endangered; C=Candidate; EXPN=Experimental Population, Non-essential

‡NE=No effect; MANLAA=May affect, not likely to adversely affect; NJ=No Jeopardy

APPENDIX G. LIST OF PREPARERS AND PERSONS/AGENCIES CONSULTED

USDA Wildlife Services

- Kristina Godwin, State Director (Retired). USDA Wildlife Services. Mississippi.
- Robert Byrd, Acting Mississippi State Director. USDA Wildlife Services. Arkansas.
- Jonathan Leddon, District Supervisor. USDA Wildlife Services. Mississippi.
- Ryan Wimberly, Environmental Coordinator (Retired). USDA Wildlife Services.
- Michael Green, Environmental Coordinator. USDA Wildlife Services.

Tennessee Valley Authority

United States Fish and Wildlife Service

Mississippi Department of Wildlife, Fisheries, and Parks

Mississippi Department of Agriculture

APPENDIX H. CERTIFYING STATEMENT FOR EA PAGE LIMIT AND DEADLINE

The Responsible Official certifies that this EA:

☒ Demonstrates the agency has thoroughly considered the factors mandated by NEPA;

☒ Represents the agency's good-faith efforts to prioritize documentation of the substantive issues and most important considerations required by NEPA within the congressionally mandated page limits;

☒ Reflects the agency's expert judgement;

☒ Addressed briefly, or left unaddressed, any issues or considerations that were, in the agency's judgement, comparatively not of a substantive nature;

☒ Represents the agency's good-faith effort to fulfill NEPA's requirements within the Congressional timeline (or within the minimally extended timeline) and this effort is substantially complete; and

☒ Contains analysis that is adequate to inform and reasonably explain the responsible official's final decision regarding the proposed action or selected alternative.