Human Health and Ecological Risk Assessment
for the Use of Wildlife Damage Management Methods
by APHIS-Wildlife Services

Chapter XXII

USE OF EXCLUSION IN WILDLIFE DAMAGE MANAGEMENT

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EXECUTIVE SUMMARY

USDA-Animal and Plant Health Inspection Service (APHIS)-Wildlife Services (WS) uses exclusion as a wildlife damage management method to remove, exclude, or limit the access of various vertebrate animals from specific areas to resolve wildlife damage situations. Exclusion methods include fencing, netting, wires, wire mesh, overhead netting, anti-perching devices, and several other barriers. Wildlife can cause damage to property, agriculture, and natural resources or cause human health and safety concerns, and exclusion is often used to eliminate wildlife access to these resources. Exclusion is used in commercial, urban, and rural settings targeting many wildlife species, including deer, rabbits, feral swine, coyotes, wolves, and numerous bird species. WS personnel generally recommend exclusion methods to resource owners and are not involved in their implantation, but WS occasionally uses and constructs exclusionary devices to resolve wildlife damage. For example, WS has used exclusion methods at airports to reduce aircraft strikes with wildlife or worked in the field to install fladry to keep wolves from killing livestock.

APHIS evaluated the potential human health and environmental risks from WS's use of exclusion methods in wildlife damage management. It determined that the risks to human health and the environment are negligible. Risks to workers are low based on WS personnel being trained in the proper use and set up of exclusion devices and wildlife handling in accordance with WS Directive 2.635. Risks to the general population are negligible because site selection and timing minimize public exposure. Exclusion devices are used to decrease wildlife interactions with resources and are not methods that would contaminate water or result in the bioaccumulation of chemicals or other hazardous materials. Environmental hazards associated with exclusion devices generally are limited to the unintentional injury or death of target and non-target species. Training WS staff in animal handling techniques reduces the risks of injury or death to target and non-target species. Risks are negligible for non-target fish and wildlife due to WS utilizing only the exclusion device specific to the resource to be protected.

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1 INTRODUCTION

Exclusion devices are used by the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) Program to eliminate and control unwanted access or interaction with animals in wildlife damage management (WDM). Exclusion methods form a barrier that reduces or stops access to wildlife species from gaining access to protected resources. The selection of exclusion method(s) reflects the target animal being excluded from an area, their size, susceptibility to self-injury, and the type of damage such as feeding, chewing, roosting, or nesting. The ability of the target animal to penetrate specific barriers, animal motivation, behavioral characteristics of the animal, and economics are used to determine the type of exclusion barrier used. The level of protection that is necessary to eliminate or reduce damage permanently, such as gaining access to a building or water sources at an airport, seasonally, such as preventing access to livestock or crops while vulnerable, or for short term, such as reducing access to wildlife during migration. Exclusion can be cost-effective, but this depends on the cost of materials and installation labor compared to the resource protected and anticipated damage.

Wildlife, such as deer[1] and feral swine, can cause damage to gardens and recently planted or ripening crops. Gulls, geese, and fruit-eating birds like robins, cedar waxwings, and house finches, can cause significant damage to crops such as grains, corn, fruits, and nuts. The wide variation of exclusion barriers can help accommodate specific areas of interest, for example, unwanted wildlife at airports. Fencing and anti-perching devices are used at airports to decrease deer, coyotes, and other mammals on the airfield and decrease perching locations for hawks and owls. Items used for exclusion can vary in size, durability, height, material, and purpose. Although fencing is a widespread exclusion barrier, bird netting, wire mesh, and anti-perching devices will also be discussed.

1.1 Exclusion Methods

Exclusion methods vary depending on the species targeted, efficacy, cost, and ease of use. The following methods describe ways to exclude animals from certain areas or resources and their efficacy.

1.1.1 Fences

Fences exclude or contain animals by providing a physical barrier, a physiological barrier (via behavioral conditioning), or a combination of both. Some fences provide a physical barrier that prevents animals from passing over, through, or under them (e.g., woven wire fences). Electric fencing, however, provides a minimal physical barrier instead, relying on an electric shock to deter animals (McKillop and Sibly 1988, Curtis et al. 1994). Fencing can be a reliable way to exclude wildlife from designated areas. Though it can be labor-intensive, costly to assemble, and require occasional maintenance, fencing often lasts many years. Fencing is good for protecting orchards, landscapes, vineyards, and tree nurseries. Fencing is cost-effective and practical when protecting small landscapes, gardens, orchards, and larger areas that may contain high-value crops or other agricultural products. For areas of lower economic value, the labor required for the construction of fencing and maintenance should be considered. Fencing is effective in deterring deer, beaver, and other pest animals. Fences may also be used to reduce flooding due to beavers by placing fencing upstream of culverts to exclude beavers from damming culvert intakes (Taylor et al. 2017).

[1] Scientific names for species are given in the text only for species not discussed in the Wildlife Damage Management Methods Risk Assessment Introduction.

Non-Electric Fencing is often erected to exclude sites from wildlife. Depending on the target animal, non-electric fencing may be a more viable option. Wire fencing is non-electrical fencing consisting of woven metal wires that create a pattern that forms a physical barrier. Wire fencing is ideal for areas that have moderate to high mammal damage (e.g., deer, feral swine) (Curtis et al. 1994, Hone and Atkinson 1983, Isleib 1995). Fences can be used to slow the spread of disease transmission, especially from animals such as deer or feral swine (Lavelle et al. 2011).

Figure 1: Polypropylene fencing or deer fencing is commonly used in areas where deer damage is low; this fencing is cost effective and a deterrent for deer.

Non-electrical fencing for deer should be at least eight feet high. Once erected, this fencing may require occasional maintenance to fix breaches created by fallen debris such as trees or limbs. Commonly used type of wire fencing is chain-link fencing and fixed knot fencing. These types of fences provide effective closures around structures and gardens. Another type of non-electrical fencing that is cheaper and effective for areas where damage pressure is light to moderate is plastic deer fencing or polypropylene fencing. Polypropylene fencing (Figure 1) is a heavy plastic mesh that can be used as an exclusion method in gardens, crops, and individual plants. It offers high flexibility and contours to the ground easily. Because of this flexibility, the polypropylene fencing can sag and can be supported with posts every 10 to 15 feet (3.2-4.1 m) using ties. This type of temporary fencing is best when long-term protection is unnecessary and a less expensive option can be used. Polypropylene fences can last about ten years, be rolled up, and be stored, whereas metal fencing may last as long as thirty years but is more permanent. Holes can form in the mesh and must be monitored for proper maintenance (Day and MacGibbon 2007).

Wire Mesh Fencing is available in many forms: woven wire or hardware cloth, chain link, welded wire, "v" mesh, chicken wire, and rigid mesh panels (VerCauteren et al. 2006). Wire mesh costs vary based on durability, lifespan, construction, and weight. Chain link fencing and wire fence panels are the most expensive, with welded wire being the least expensive. A woven-wire fence made of 12.5 galvanized high-tensile steel is an ideal exclusionary material for ungulates such as deer. When manufactured with tension curves on horizontal wires, the fence material has the elasticity to reduce harm to an animal impacting it and facilitates installation on uneven terrain (Bryant et al. 1993). The addition of a skirt going outwards a few feet at the bottom in an "L-shape" prevents animals from digging under the barrier to get into restricted areas. Wire mesh fencing is often used to reduce wildlife-vehicle collisions along highways with high traffic volume within migration corridors. A 7.9-foot (2.4m) wire-mesh fence along an interstate in Wyoming was effective in reducing collisions when used in conjunction with underpasses (Ward 1982) and reduced deer-vehicle collisions by 80% along a highway in Banff National Park, Alberta, Canada (Clevenger et al. 2001). Wire cages are often used for protecting individual plants that can be browsed by herbivores or rubbed against by antlered animals. Wire cages and plastic mesh screens are commonly used to protect endangered species' nests, such as sea turtles, from beach-foraging mammalian predators. (Phillott 2020, Kurz et al. 2012).

Electric Fencing has historically been used for containing livestock and restricting wildlife from an area or commodity. Factors such as voltage requirements, fence configuration, charge configuration, seasonal fences, and attractants should be examined when considering electric

fences. It is important to know the target animal's physical capabilities and behavioral aspects to provide an efficient electric fence barrier. For example, standard fence designs used to contain livestock typically include three- to six-strand barbed wire and single and multi-strand electric wire. It is also common for post and rail and stockade-type fencing to be used to contain livestock. This fencing proves effective for livestock, but it would not be ideal to exclude white-tailed deer (VerCauteren et al. 2006). Electric fencing primarily functions as a psychological barrier due to the electric shock instead of a physical barrier. The electricity is used as a deterrent for animals to prevent them from wanting to cross the fenced area. For example, an adequate voltage to deter deer would be a minimum charge of 3,000 volts and most effective on high-tensile wire and poly-tape materials (Matschke et al. 1984, Duffy et al. 1988, Curtis et al. 1994). Electric fencing can last up to thirty years and be less expensive than woven wire fencing.

Electric fencing contains animals or pests with bad climbing abilities, such as rabbits, hares, and ferrets. Electric fencing does not effectively contain animals with good climbing and jumping abilities, such as deer, coyotes, and foxes (Day and MacGibbon 2007). Electric fencing has also been used successfully to deter bears from accessing apiaries, fruit orchards, and other attractants (Lackey et al. 2018). The most basic electric fencing design consists of wires that conduct an electric charge and are supported by wood, metal, or plastic posts and a charging system that supplies an electric current to the fence wires. Some or all of the wires on an electric fence conduct electricity. Animals must be grounded to get shocked, touch either a ground wire or a charged wire simultaneously, or touch a charged wire and the ground grounded with a grounding rod. Electric fencing should not be used in residential areas. It is important to identify an electric current running through the fence to prevent injury to people, so warning signs are of high importance. The wires used for the electric fencing should be smooth and charged using a commercially available fence charger. The shock they administer is intermittent, therefore, safe for humans and animals. Direct current and barbed wire should never be used for electric fences because their use may cause electrocution. Electric fencing may be baited with attractants, so the target animal is more likely to contact the fencing and get shocked. It is important to keep the fence baited to encourage the target animal to touch it; once the fence stops being baited, the target animal may try to get into it. Once crops have been sampled, keeping target animals out of the crop is almost impossible. To help prevent collision or injury to non-target animals, using brightly colored flags or tin cans to help with the visibility of the fence is important.

1.1.2 Netting

Netting is used as a barrier to exclude smaller birds from high-value crops (Tillman et al. 2000), buildings (Slater 1998), and aquaculture (Taber 2002). Bird-exclusion netting can be highly effective in reducing bird damage. However, the high cost of materials and labor for installation can be cost-prohibitive for lower-value commodities. Netting is commonly used for flocking bird species such as pigeons, blackbirds, swallows, starlings, and wading birds such as herons and egrets.

1.1.3 Overhead Wires

Overhead wires, steel or monofilament, are another exclusion device used in WDM. Wires can be easier to erect than netting and are often more cost effective for smaller projects. However, large ones covering more than several hundred square feet adjacent to dams have been erected to protect T&E fish species on the Columbia River. The wire is constructed in parallel lines over the site that needs to be protected. Wire has also become an effective tool in eliminating the access of gulls and other birds from sites (Solman 1994). A diameter of 0.03 in (0.8mm or 20

gauge[2]) or greater is recommended if steel wire is used. When using monofilament (a single strand of material, commonly plastic, with 100-pound test), it is important to test the line to ensure it is strong enough to handle the weight of landing or collision.

Lines can be made visible for birds using aluminum foil or other reflective objects hanging from the line. But often, the element of surprise is a sufficient tactic to keep birds from landing and perching on the lines. It is important to consider the species of bird that is the target animal to ensure that wire spacing effectively eliminates access for birds into restricted areas. It is also important to note that wire is less effective on smaller birds. The wire should be checked daily for debris, tears, or objects or birds entangled in the line. This method is more cost-effective than bird netting (Duffney 2006, Pochop et al. 1990).

1.1.4 Fladry

Fladry is a barrier device explicitly used for predators, such as coyotes and wolves. Fladry alleviates livestock predation by taking advantage of wolf and coyote fear of unfamiliar items on the landscape (Windell et al. 2021, Young et al. 2019). Fladry consists of a continuous rope strand with strips of flagging sewn or tied at 20 in (50 cm) intervals and strung 20 in (50 cm) from the ground for wolves. Closer spacing of fladry has been shown to be more effective with coyotes (11 in, 28 cm) (Young et al. 2019). Turbo fladry is modified from typical fladry by carrying an electric charge along the rope. Recent testing of turbo fladry conducted by the WS Feral Swine Task Force (unpublished data) to protect crops from feral swine damage had positive results. Fladry can protect prairie dog colonies, black-footed ferrets, and livestock, especially during critical seasons (e.g., calving) (Windell et al. 2021).

1.1.5 Anti-perching Devices

Anti-perching devices include porcupine wire (e.g., Nixilite®, Bird-Flite®, and Cat-claw®), floppy wire (Daddi Long Legs™ and Bird Barrier Coil®), spring-tensioned wires, and shock strips. These types of devices can be used to keep birds from perching in particular areas (Figure 2). They are often attached to fences, signs, light fixtures, and ledges at airports and other areas where birds are not desired (Seamans et al. 2007). These devices help reduce roosting, loafing, and associated bird fecal accumulation, which can deface resources due to its acidity. If bird fecal matter accumulates on top of buildings or other surfaces, it can become a human health and safety hazard and damage resources such as bridges and statues over time. Anti-perching devices can be effective at repelling birds. Still, debris build-up from a lack of maintenance, misshapen rods or wires from weather or larger animals, normal wear-and-tear, and nonfunctioning electrical systems for electrical wires and mats can reduce efficacy.

Figure 2. Example of an anti-perching device (e.g., Nixilite®) installed on a ledge to keep pigeons from landing.

Anti-landing devices include floating plastic balls called Euro-Matic Bird Balls™ that have been used at airports, mine, sewage treatment, sludge, and livestock waste settling ponds to keep birds

[2] Wire gauge goes down as wire gets wider such as from 20 ga. to 8 ga.

from landing on ponds. These devices can prevent birds from landing that may succumb to the toxicants or spread them outside of the damaged area. Water in airports attracts birds like gulls that are strike hazards. The balls are an effective barrier to keep birds from using the water source (Advanced Water Treatment Technologies 2017). WS may recommend anti-landing devices to cooperators but does not employ them operationally themselves. Cooperators would be expected to deploy them directly. Once installed, the bird balls can last and provide other benefits to the users other than just repelling birds.

1.1.6 One Way Doors

One-way door cages (Figure 3) are an exclusion barrier used to remove pests from structures or burrows. The trap blocks an opening into an enclosure, preventing re-entry into the structure or burrow. The one-way door is designed with a slant to encourage animals to push the door to enter the cage, and as it shuts behind them, they remain enclosed in the cage or trap. Baiting provides an attractant to get the target animal to enter the trap, but it is unnecessary. Understanding the size of the target animal is important to determine the size of the cage. It is also important to know how many one-way door cages you may need to exclude all target animals.

Figure 3: One-way doors allow target animals to exit structures without the ability to regain entrance, so they may be removed.

1.1.7 Fill/Seal Gaps

Gaps that allow wildlife to enter areas where they are not wanted are sometimes filled with wire mesh, sheet metal, patching compounds, chalking, concrete, steel wool, dirt, or other materials that prevent entry. Rodents can fit through about any hole they can get their head through (e.g., house mice and brown rats can squeeze through any opening greater than 0.25 inches and 0.5 inches, respectively). The more durable the product, the more likely it will repel the animal. Some will just be reopened (rodents gnaw through many materials, predators and rodents dig under fences, and birds such as woodpeckers can drill new holes). Wildlife should be removed from the area of concern prior to sealing access points to avoid trapping wildlife inside structures. Today, new buildings, bridges, and other structures often limit typical pest species' nesting areas and access points.

1.1.8 Entrance Barriers

Entrance barricades of various kinds are used to exclude several bird species, such as starlings, pigeons, and house sparrows, from dwellings, storage areas, gardens, or other areas. Heavy plastic strips hung vertically in open doorways (Figure 7) have been successful in some situations in excluding birds from warehouses and buildings, especially used for indoor feeding or housing livestock (Johnson and Glahn 1994), a biosecurity measure. Plastic strips, however, can prevent or substantially hinder the filling of feed troughs or feed platforms at livestock feeding facilities. Such strips can also be covered up when the feed is poured into the trough by

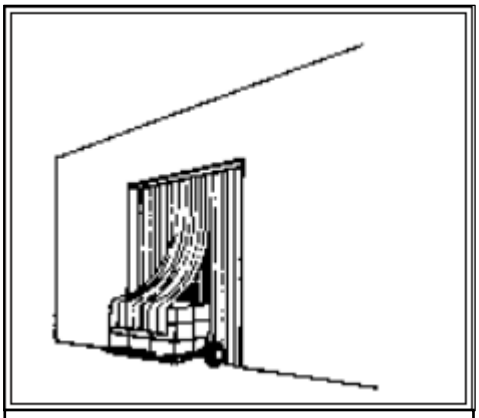

Figure 4. Entrance barricade to deter birds.

the feed truck. They are not practical for open-air feedlot operations that are not housed in buildings. Metal flashing or hardware cloth may be used to prevent the entry of wildlife into buildings or roosting areas.

1.2 Use Pattern for Exclusion

WS occasionally uses barriers to remove or block access to wildlife, including filling holes under fences, using one-way door cages to remove animals, fladry, and wire mesh or plastic netting to keep species from accessing areas. Because it is difficult to determine the number of animals repelled from the use of exclusion barriers, few entries are recorded in the MIS[3]. Additionally, these techniques are generally recommended to the property owner rather than installed by WS. From FY16[4]-FY20, an annual average of 337 animals were repelled or evicted from areas in 9 states and 1 territory.

Table 1. The annual average number of target species repelled with barriers used by WS in wildlife damage management from FY16 through FY20.

Species	Exclusion Method	Repelled/Exited	States Where Used
Black Bear	Fill crawl hole	0.2	AK
Coyote	Fill crawl hole	2	CA
Fill Crawl Hole Total (2 sp.)		**2**	**2 States**
Virginia Opossum	One-way-door	0.8	CA
Northern Raccoon	One-way-door	12	CA
Striped Skunk	One-way-door	75	CA
California Ground Squirrel	One-way-door	40	CA
One-way Door Total (4 sp.)		**127**	**1 State**
Brazilian Free-tailed Bat	Nest/roost wire mesh	202	TX
Canada Goose	Nest/roost wire mesh	1	MA
Pelagic Cormorant	Nest/roost wire mesh	0.8	OR
Osprey	Nest/roost wire mesh	2	FL WV
European Starling*	Nest/roost wire mesh	1	PA
Nest/Roost Wire Mesh Total (5 sp.)		**207**	**6 States**
Trumpeter Swan	Plastic netting	0.4	IA
Barn Swallow	Plastic netting	0.4	PR
Plastic Netting Total (2 sp.)		**0.8**	**1 State, 1 Territory**
TOTAL (13 sp.)		**337**	**9 States, 1 Territory**

* Introduced species

Fewer work tasks related to exclusion devices were recorded between FY11 and FY15, with an annual average of 32 animals repelled. Feral pigeons (0.8 dispersed) were excluded from building nest sites. Mixed blackbird species (26 dispersed) were blocked from roost sites. Ospreys (0.4 dispersed) were excluded using netting at the Space Center; this was an attempt to block nesting structures so nesting would not continue. Burrowing owls (0.4 dispersed) were excluded from using one-way doors on ground squirrel burrows on an airfield where they are a strike hazard. Coyotes (1) were blocked with barriers at crawl-through spaces under fencing that led into the air operations area of an airport. Striped skunks (2) were excluded through one-way doors used under residences. Eastern gray squirrels and fox squirrels (0.6 dispersed each) were excluded

[3] MIS - Computer-based Management Information System used for tracking APHIS-WS-WDM activities nationwide. Throughout the text, data for a year (i.e., FY11 (next footnote)) will be given and is from the MIS. MIS reports will not be referenced in the text or Literature Cited Section because MIS reports are not kept on file. A database is kept that allows queries to be made to retrieve the information needed.

[4] FY16 equals the federal Fiscal Year 2016 which is October 1, 2015-September 30, 2016.

from nesting areas at industrial sites. Beaver were excluded with fencing from blocking a culvert to prevent damage to roads and bridges.

Exclusion barriers used by WS require labor, monitoring, and occasional maintenance. Barriers must be monitored to ensure no debris, entangled animals, or breaks and tears in the materials have occurred.

2 HAZARDS

2.1 Human Health and Safety Hazards

Human health and safety hazards associated with exclusion barriers include potential cuts or abrasions from loose wires, snags, or sharp edges on the equipment, electric shock from electrified fences, and possible strain from labor and maneuvering of materials. Most injuries occur while setting, or maintaining exclusion barriers, due to the labor of erecting these structures to perform efficiently. Muscle strains could also occur during the construction or placement of exclusion barriers because of the large fencing sheets or the moving of structural supports. Cuts and abrasions are common when using barbed wire or other materials containing sharp edges, points, and other deterrents. Removing target and non-target animals from exclusion barriers may lead to bites or scratches. It is important to wear proper protective gear and evaluate the situation for safety concerns.

Handling wildlife entangled or caught on/in exclusion barriers could also result in hazards associated with disease and parasite transmission from target and non-target wildlife (Animal Care Use Committee 1998, WS Directive 2.635). For example, target animals such as white-tailed deer and other ungulates can be hosts for diseases such as bovine tuberculosis (Schmitt et al. 1997), chronic wasting disease (Miller et al. 1998), brucellosis (Rhyan 2000), and Lyme disease. Bovine tuberculosis is a bacterial disease established in wild white-tailed deer herds in northern Michigan and can be readily transmitted to cattle through direct contamination or environmental contamination (Kaneene et al. 2002). White-tailed deer also serve as a host for the primary vector of Lyme disease. Reducing the concentration of deer can reduce the occurrence of Lyme disease in humans (Kilpatrick and LaBonte 2003). The recent increase in outbreaks has emphasized the importance and need for exclusion devices to reduce potential disease transmission between domestic and wild animals and humans. The same injury and disease hazards extend to the public who encounter and tamper with animals that are caught in exclusion barriers placed by WS.

2.2 Ecological Hazards

Ecological hazards associated with exclusion barriers include capture, injury, or death to non-target animals. These ecological hazards can be avoided by monitoring exclusion barriers and maintaining the condition of the materials used. It is important to understand other animals may come into contact with the exclusion barrier. It is common for non-target animals to get injured and entangled by colliding with exclusion barriers when attempting to pass through or under barriers. Allowing for the barriers to be visible can keep non-target animals from colliding with the barriers and getting entangled. Using bright markers or making sure posts are closer together can help many animals prevent possible injury. Materials used around bodies of water should be closely monitored due to the possibility of contamination and harm to non-target wildlife through ingestion and strangulation. Another environmental risk that exclusion barriers can cause is the disruption of emigration and immigration (Nielsen et al. 1997). Exclusion barriers can disrupt the movement of animals such as deer, causing detrimental effects on wildlife migration (Owen and

Owen 1980). Fencing can be constructed to be semipermeable in some instances to exclude the target species but still allow for non-target animals to pass (Robb et al. 2022). Fencing can cause hazards to grouse due to collisions with wires in rangeland habitats. Fence-marking methods can mitigate these hazards (Stevens et al. 2012).

3 RISKS

3.1 Human Health and Safety Risks

Human health and safety can be affected by unwanted target animals through interactions on roadways and in areas where aircraft are present such as airports. Exclusion barriers can prevent the risk of animals causing automobile collisions and aircraft malfunctions, which can damage property and cause human casualties. This is a very common issue on roadways as deer often graze in fields parallel to roadways that may have high traffic volume. It was estimated that deer-vehicle collisions cost approximately $1.6 billion annually (Conover 2002). White-tailed deer were also determined to be the most hazardous mammal on airport runways, causing an estimated $52,909,864 in damage per aircraft collision between 1990-2020 (Dolbeer et al. 2021).

Human health and safety can also be compromised with animal interaction because many animals can have diseases that are zoonotic to humans and domestic animals. White-tailed deer, in particular, are common carriers of diseases such as bovine tuberculosis, and Lyme disease (DeNicola et al. 2000). Feral swine can carry zoonotic diseases to humans, including brucellosis, bovine tuberculosis, and leptospirosis, among others (Brown et al. 2018). Exclusion barriers help eliminate access or interaction from potentially contaminated animals to other animals and humans. Lyme disease can easily be transmitted from animals to humans, causing a need to reduce the concentration of deer in unwanted areas (Kilpatrick and LaBonte 2003). Canada goose conflicts in the eastern United States include intensive foraging and localized (aquatic and terrestrial) fecal contamination in recreation areas (Conover and Chasko 1985). The close proximity of geese and humans increases the risk associated with pathogenic bacteria prevalent in Canada goose feces (Kullas et al. 2002).

During FY16-FY20, WS employees had an annual average of 2.6 injuries from falls, slips, and repetitive activities that resulted in lacerations, sprains, contusions, strains, and bruises associated with field activities, specifically related to exclusion activities. These were mainly due to installing posts for temporary fencing, one injury due to removing an eagle from netting excluding birds from a fish hatchery, and two tick exposures installing fencing and fladry in the field. Considering the number of WS employees (~1,900), these claims are relatively few for the number of hours spent afield. Thus, the risks of deploying exclusion devices are relatively minor to employees.

Overall, risks to workers are low based on WS personnel being trained in the proper use and set up of exclusion devices and wildlife handling in accordance with WS Directive 2.635. Risks to the general population are negligible because site selection and activity timing minimize public exposure.

3.2 Ecological Risks

Ecological risks include risks to all non-target animals. When target animals are excluded from areas that are often their feeding grounds, it is not common for them to find another location to feed. They will often move to a nearby unprotected area (Isleib 1995). The addition of habitat loss may cause the target animal to concentrate in smaller areas. This could cause existing damage

to become greater and increase the likelihood of disease transmission to non-target and domestic animals. There can also be risks involved in areas of high stress, which can cause the ability of human health hazards to increase. For example, stressed deer are driven by non-typical behaviors, and under certain circumstances (e.g., being pursued by a hunter), they will penetrate exclusion barriers such as fences that would typically deter them (Bryant et al. 1993, Conover 2002). The stress that target and non-target animals can exhibit when being excluded can lead to unintentional death or injury.

Risks to non-target animals are reduced by proper placement and selectivity of barriers. WS recommends the appropriate barrier for the situation to prevent non-target effects or by adding marking materials to reduce hazards to non-target species from barriers. Additionally, fencing can be constructed to be semipermeable in some instances to exclude the target species but still allow for non-target animals to pass (Robb et al. 2022).

4 UNCERTAINTIES AND CUMULATIVE EFFECTS

Uncertainty in this risk assessment is negligible as APHIS-WS has used various styles of exclusion barriers for WDM activities and understands the potential risks of erecting and maintaining exclusion barriers. The knowledge gained from this experience has helped reduce risks associated with exclusion barriers, especially regarding human health and safety, due to encounters with entangled or injured animals and injuries due to exclusion barriers such as fencing, both electric and non-electric, and neglected maintenance.

Cumulative impacts could occur to target and non-target animals. However, cumulative impacts are addressed in National Environmental Policy Act documents and found not to be significant to any native species population. Additionally, the "Introduction to WS Methods Risk Assessments," Chapter 1 gives all species taken by WS from FY11 to FY15 and shows no significant impacts from a population standpoint. From a human health perspective, the use of exclusion barriers in WDM will not have any known cumulative impacts.

5 SUMMARY

The use of exclusion methods in WDM is an effective and nonlethal method for protecting crops, livestock, and other agricultural and domestic products. Exclusion barriers, such as fencing, wire, netting, spikes, etc., are exceptional in maintaining health, safety, and value in structures, gardens, orchards, and livestock production areas. Exclusion barriers are often a tool in an integrated wildlife damage management program. It is important to understand the efficiency of any exclusion barrier is limited to material, proper maintenance, effectiveness in excluding animals based on physical and behavioral characteristics, and overall motivation of the target animal to penetrate a specific exclusion barrier.

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7 PREPARERS

7.1 APHIS WS Methods Risk Assessment Committee

Writers for "Use of Exclusion in Wildlife Damage Management":

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7.2 Internal Reviewers

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7.3 Peer Review

The Office of Management and Budget requires agencies to have peer review guidelines for scientific documents. The APHIS guidelines were followed to have "Use of Exclusion in Wildlife Damage Management" peer reviewed. WS worked with the Association of Fish and Wildlife Agencies to have experts review the documents.

7.3.1 Peer Reviewers Selected by the Association of Fish and Wildlife Agencies

Montana Fish, Wildlife & Parks

Washington Department of Fish and Wildlife

Oregon Department of Fish and Wildlife

7.3.2 Comments

1. The document is specific to terrestrial situations and should be stated to avoid any questions/concerns that aquatic exclusions (e.g., fencing/screening culverts to avoid blockage by beavers) are missing.

Response: We unintentionally excluded aquatic exclusions from the draft document. We have included information about aquatic exclusions in sections 1.1 and 1.2.

2. Do these descriptors adequately cover hardware cloth and chicken wire? Or are those not materials utilized by WS and therefore not included?

Response: Hardware cloth is a type of woven wire. We have identified hardware cloth and chicken wire as types of wire mesh fencing in this paragraph.

3. Unfortunately, wildlife conflict and damage issues are often situational and site specific. It will thus be incumbent upon USDA staff to ensure that the tools and methods chosen for handling a specific wildlife conflict situation are appropriate to those circumstances, not just be considered for the species without those site considerations also being an important factor.

Response: We agree that wildlife damage management is situational and site specific. Throughout the Risk Assessment, we indicate that tools are chosen for specific areas and species. WS specialists are trained to know what methods to use in different situations and for specific species.

4. APHIS staff should also be cognizant of site specific considerations for non-target species impacts where it is possible that removal of only a few individual non-target animals could have a larger impact on management and species recovery. Certain species that the state has listed as having Greatest Conservation Need exist in geographically small areas and already have recovery challenges. Several of these species may not have Federal protection and yet are state species of concern. APHIS may access this information on our public webpage, link below, in order to have access to the current Priority Habitats and Species (PHS) data files. This information should help APHIS avoid impacts on non-target state species of concern. If further information is needed to make such a site determination, state personnel can assist with further details.

Response: This Risk Assessment is broad in scope to cover the general activities of WS employees throughout the US and its territories. State programs identify state species that WDM activities may impact in their individual state Environmental Assessments or Biological Opinions with USFWS. Stat**E PROGRAMS** also identify state-listed species that may not have Federal protection but are state species of concern. We appreciate the provision of information to help state programs identify species within individual states.

5. Within the Executive Summary on page I, there is a list of species that exclusion methods have been used for by WS, but elk is not listed. I know exclusion works for elk, but I don't know if WS has ever used it for this species.

Response: WS does conduct wildlife damage management with elk when requested. The period covered by this risk assessment did not include exclusion methods for elk specifically. However, in recent years, eight-foot woven wire fences have been used to help prevent elk grazing damage to valuable crops. WS may also use repellents and other methods to help alleviate damage by elk.

6. Throughout the document, "minimize" is generally used when "reduce" might be a better choice. If complaints are minimized, that could mean that it is made little of or that complaints are reduced. The word reduce eliminates any confusion. I recommend the use of reduce throughout the document.

Response: We have changed the word "minimize" to reduce throughout the document.

7. On page 3, there is some discussion about electric fencing. Electrified fencing and panels are also valuable in limiting access by black bears. Another reference that would be useful is another Human-Wildlife Interactions Monograph, specifically Lackey et al. 2018 entitled Human-black bear conflicts: a review of common management practices.

Response: We have added this reference relative to electrified fencing for black bears.

8. On page 5, top paragraph, the second to last sentence is confusing. It says WS typically recommends these and does not use these operationally. I am assuming that this means, "WS typically recommends the use of bird balls but does not employ them operationally themselves. Operators are expected to employ them." I believe that clarifies the intent, but if not, the sentence is even more confusing than I first believed.

Response: We have reworded this sentence for clarity. WS recommends using bird balls and other anti-landing devices but does not employ them operationally. A cooperator would be advised to deploy them.

9. Similarly, on page 6, the first sentence under 1.2 Use Pattern for Exclusion, the sentence begins, "WS minimally uses barriers…." I'm not sure what that means. I believe it means "WS does not often install barriers to remove or block access…." This sentence should be rewritten for clarity.

Response: We have reworded this sentence for clarity. WS occasionally, or not very often***,*** uses barriers to remove or block access to wildlife.

10. On the same page below Table 1, the first sentence is also rather obtuse. "Data recorded between FY 11 and FY 15 was less…." Does this mean "Less data was recorded between FY 11 and FY 15…" If the data was less, it could be lower numerically or fewer in number. Clarification would help.

Response: We have reworded this sentence for clarity. WS recorded fewer work tasks related to exclusion devices during FY11-15 than during FY16-20.

11. On page 8, in the concluding remarks about fencing, it could be pointed out that fencing can be constructed to be semipermeable in some instances. Fencing may exclude equids while allowing cervids access. Electric fences may be constructed so that some species may still pass through while others may be repelled. The design and construction of fencing can allow substantive specificity in effect.

Response: We have included a statement and reference regarding the permeability of fences to alleviate risks to non-target species.

12. The second paragraph under 31. Human Health and Safety Risks is misleading and should be revised substantially. It states that CWD can potentially be spread to humans and domesticated animals by livestock. This really stretches credibility. CWD to date has not been detected in anything but cervids. Although CDC has certainly placed prudent precautions in place regarding CWD, this is not a good example of the benefits of exclusion. It begs credibility. Many other diseases may be implicated, but I would recommend removing any reference to CWD in this section. It has not been documented to be a zoonotic risk at this time. The point may be made without referencing CWD.

Response: We agree with this comment that CWD is not a zoonotic risk at this time in that no cases of human prion disease caused by CWD have been recorded, and most experimental data suggests that the zoonotic risk of CWD is very low (Tranulis and Tryland 2023; The zoonotic potential of chronic wasting disease- a review). We have removed the sentences in this section related to CWD.

13. On page 9, under 3.2 Ecological Risks, there is an opportunity to reemphasize the semipermeable nature of some features, such as fencing.

Response: We have included a sentence reemphasizing the semipermeable nature of some features to potentially aid non-target species.

Comments received not requiring a response.

1. The department believes the current proposals to reduce or mitigate risks to wildlife, property, domestic animals, or persons while applying conflict tools and methods is adequate.

2. The use of exclusion is among the most benign regarding effects on wildlife and human health when addressing wildlife damage management. I believe this risk assessment does a good job of detailing potential issues and describing the scope of that effect.