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

Chapter XVI

The Use of Egg Addling in Wildlife Damage Management

August 2018

Peer Reviewed Final
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THE USE OF EGG ADDLING IN WILDLIFE DAMAGE MANAGEMENT

EXECUTIVE SUMMARY

USDA-APHIS-Wildlife Services (WS) uses egg addling to alleviate damage associated with bird nesting activities or to discourage nesting in an area where damage has occurred. The goal of egg addling is to manage birds that cause damage to property, agriculture, and natural resources or are potential threats to public safety. WS "addling" refers to oiling, shaking, or puncturing an egg during incubation to render the embryo unviable. When oiling eggs, WS uses food grade 100% corn oil to coat the egg, which blocks the egg's pores and prevents the exchange of oxygen, ultimately killing the embryo. Between FY11 and FY15, WS oiled an annual average of 60,000 eggs with mostly gulls (54%), double-crested cormorants (31%), and waterfowl (14%) being targeted. Shaking and puncturing were used very little or not at all. WS used about 38.5 gallons of 100% corn oil on these eggs. WS did not use the puncture method to addle eggs during this period.

The Animal and Plant Health Inspection Service evaluated the potential human health and environmental risks from the WS proposed use of egg addling and determined the risks are negligible. WS personnel are at risk of receiving bites, scratches, and wing attacks from aggressive birds during the process; however, WS trains personnel in the proper way to handle bird eggs and defensive techniques for aggressive birds in order to minimize this risk.

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1 INTRODUCTION

The U.S. Department of Agriculture (USDA), Animal and Health Plant Inspection Service (APHIS), Wildlife Services (WS) Program uses egg addling to manage bird damage caused by species such as Canada geese[1] and gulls that damage property, agriculture, or natural resources, or are a public safety concern or disease threat. Egg addling is a method that terminates embryo development through shaking, puncturing, or oiling the egg and placing the egg back in the nest. Returning the egg to the nest misleads the sitting adult(s)[2] into believing the egg is still developing. Otherwise, the female would, in most cases, simply renest, often at a new location. The removal and destruction of eggs is covered in "The Use of Hand Capture and Disease Sampling in Wildlife Damage Management" risk assessment, as these are removal methods rather than addling and are often used in different situations (removal is often used to encourage the adults to nest elsewhere).

Egg addling for most targeted species of birds can only be conducted with proper authorization or permits from the official management agency for the target species, but permits are not required for all species, especially species that are invasive. WS personnel abide by federal, state, and local laws and WS policies (WS Directive 2.301[3]) when conducting egg addling operations.

1.1 Egg Laying and Incubation

Some specifics of egg laying and subsequent incubation behaviors are important in selecting the appropriate time to addle eggs. All species of birds lay eggs, but incubation starts at different times depending on the species. Incubation, also known as brooding[4], is the process of embryonic development inside the egg. Eggs can lay latent for an extended period of time after laying as long as the ambient temperature is not too hot or cold. Embryo development ensues once the egg is warmed by a sitting adult, but not until that point.

Incubation in most species (~95%) is either shared by both parents (e.g., double-crested cormorants, pigeons, woodpeckers, and starlings) or completed by the female alone (e.g., upland game and some waterfowl). In some species (~5%) the male is solely responsible for incubation (e.g., phalaropes and jacanas). In monogamous pairs (females and males have a single mate), incubation is typically completed by the female or both parents; if it is solely the female, the male may feed or protect her on the nest. In polygamous species (males mate with more than one female during the season) such as mallards, only the female sits on the nest, whereas in polyandrous species (females mate with more than one male), the male is responsible for incubation (e.g., phalaropes and jacanas). In several polyandrous species, the males sit on the first clutch while the females sit on the second clutch if one is laid. Finally, some species are parasitic egg layers in that they lay their eggs in other species' nests (e.g., cowbirds and cuckoos), or sometimes into a conspecifics' nest (e.g., canvasback - 10% of the eggs laid are in other's nests (Sorenson 1993)). When eggs are laid into other species' nest, the eggs typically hatch in a relatively fewer amount of days. Additionally, since the parasitic species' nestlings are often bigger, they may remove "siblings" from the nest.

In some species, incubation begins immediately after the first egg is laid while some species wait until an entire clutch has been laid (up to a dozen eggs at a rate of one laid per day). Eggs incubated immediately are usually those with altricial young (young that are unable to move after

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

[2] Adults sitting on eggs can be female, male, or both, depending on the species.

[3] WS Directives can be found @ https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage but will not be listed in Literature Cited Section.

[4] Some Australian bird species, incubate eggs in rotting detritus or sandy areas and do not sit on the nest.

hatching and dependent on the parent for food and care). Generally, the oldest nestling is fed first and younger nestlings get fed if enough food is available. Raptors tend to fall in this category. In contrast, when parents allow the eggs to lay latent until an entire clutch is laid, the young tend to hatch together or simultaneously. The hatchlings of these species tend to be precocial (able to walk and feed themselves almost immediately). Waterfowl and upland game tend to fall into this category.

Several species of birds raise more than one clutch a year or renest if the first clutch fails. Addling is most effective for those species that lay one clutch per year and only renests if the first clutch fails shortly after the onset of nesting. Simply removing eggs is an effective method for some situations such as when a nest is in a disadvantageous location where nesting adults may attack people (this is a common complaint for many species such as Mississippi kites[5]). However, egg removal usually does not help with population suppression because birds typically will immediately renest in a new location. Alternatively, if the adults continue to incubate a clutch of addled or unviable eggs, they may not renest at all.

Addling is most effective shortly after the onset of incubation and after the entire clutch is laid. Baker et al. (1993) suggested that, in the interest of humaneness, eggs should be oiled as early in the incubation process as possible. Typically, this is five days after the onset of incubation to 5 days prior to hatching. Nesting chronologies can be estimated via egg flotation (Nol and Blokpoel 1983, Rizzolo and Schmutz 2007, Reiter and Andersen, 2008), and eggs near their hatching date can simply be removed as the adults are not likely to renest. WS personnel typically use this technique for bird damage management projects. At times, WS may avoid treating target species in nesting colonies adjacent to sensitive species nests to avoid negative impacts on the sensitive species.

1.2 Addling Methods

Shaking, oiling, and puncturing are the three methods used to addle eggs. WS tends to rely on oiling and some shaking to addle eggs. Primary target bird species include gulls, waterfowl, and double-crested cormorants. After oiling, shaking, or puncturing, the eggs are returned back to the nest. Most birds remain on the nest beyond the expected hatching date, thus, reducing or preventing the potential for renesting. When eggs are addled, they are often marked (Figure 1) to ensure one treatment and to be able to go back 7-10 days later to oil any additional eggs laid (Smith et al. 1999). Adults, especially male geese, tend to defend the nest more intensely on subsequent visits and often it is better to have two personnel present to reduce injuries while addling eggs (Smith et al. 1999).

Figure 1. Eggs are often marked prior to addling to ensure one treatment and return to addle additional eggs laid 7-10 days later.

[5] Nests are often removed for species that attack people near homes or businesses and eggs may be turned over to wildlife rehabilitators for incubating, raising, and releasing.

- **Egg Oiling** – Coating the egg with 100% food grade corn oil blocks its pores and prevents oxygen from entering the egg. Without access to oxygen, the embryo inside the egg ceases to develop due to asphyxiation (Blokpoel and Hamilton 1989, Christens et al. 1995). Prior to oiling, eggs may be marked, (Figure 1) however, when oiling numerous target eggs at a time, marking is infrequently used. Oiling can be conducted by numerous methods including wiping the eggs with an oil-soaked cloth (Figure 2), spraying oil with a handheld pump action sprayer (Figure 3) or pressurized backpack sprayer, or simply dipping the egg in a bucket or container of oil. The most effective application is a thinly coated layer of oil covering the surface of the entire egg (WS 2009), using about 2 milliliters (mL) of oil per egg (Pochop et al. 1998); since the researchers were using chicken eggs, it is likely 4 mL is required to oil larger species eggs such as pelican and goose eggs, and 6 mL for swan eggs (the surface area for a chicken egg is about one third of a mute swan egg). Several types of oils have been tested for this purpose including mineral oil, but corn oil has been used for many years because it is relatively inexpensive, easily available, and as effective as other oils (Pochop et al. 1998). Paraffin has also been used effectively and suggested not to bother the plumage of waterfowl (Baker et al. 1993). However, if excess oil is wiped from the egg, no effect on plumage has been noted. Corn oil (100%), and many additives are not regulated as pesticides by the U.S. Environmental Protection Agency (USEPA) under the Federal Insecticide, Fungicide, and Rodenticide Act because it meets all exemption requirements of products that pose no or minimal risks to public health and the environment (Federal Register Notice March 6, 1996, 66(45):8876-8879) and remains on the list of minimum risk pesticides (USEPA 2015).

Figure 2. Oiling eggs with a cloth soaked in oil.

Figure 3. Oiling eggs with a handheld, pump-action sprayer.

- **Egg Shaking** – This method of addling involves vigorously shaking an egg to disrupt the internal egg membranes until the internal fluids can be heard sloshing around. Eggs are typically marked prior to shaking (Figure 1). After the eggs are shaken, they are placed back in the nest to reduce the likelihood of renesting. WS uses this method less often than it uses egg oiling because shaking the egg may not be as effective at rendering the egg unviable as oiling the egg.

- **Egg Puncturing** - Eggs are sometimes punctured to addle them. To ensure the egg is addled, it is held securely in a hand that is braced against the ground and a long, thin metal probe is inserted into the pointed end of the egg with slow steady pressure. When the probe is passed through the egg, the tip of the probe is inserted until it hits against the inside of the shell at the opposite side of entry, and the egg is swirled in a circular motion to emulsify the yolk sac, ensuring the embryo is unviable.

1.3 Use Pattern

WS uses egg addling for projects primarily involving gulls, waterbirds, and waterfowl, especially where nesting colonies are in close proximity to airports (i.e., to reduce bird strikes) or where they are damaging property and recreational areas. For FY11-FY15, most take (92%) involved just four species, ring-billed gulls (34%), double-crested cormorants (31%), Canada geese (14%), and laughing gulls (13%) for the protection of public recreational areas (disease related) and property. WS oiled and addled an annual average of 60,001 bird eggs during FY11 to FY15 and an estimate of 38.5 gallons of 100% corn oil was used with the majority of eggs being oiled (99.9%), few with shaking (>0.1%), and none with puncturing (Table 1). No nontarget species were accidentally taken in this time period. It should be noted that egg take for FY16-FY20 was added in Appendix 1, Table 1.1. Take between FY16-FY20 was less than take between FY11-FY15 for most species.

Table 1. The annual average target bird egg take with addling by WS in wildlife damage management throughout the United States for FY11-FY15.

ANNUAL AVERAGE EGGS OILED/ADDLED BY WS FOR FY11 TO FY15			
Species	**Eggs**	**Estimated Corn Oil (oz.)[1]**	**No. States**
EGG OILING			
Laughing Gull	8,045	575	5
Ring-billed Gull	20,659	1,476	2
California Gull	381	27	1
Great Black-backed Gull	37	3	4
Glaucous-winged Gull	1,597	114	1
Herring Gull	1,621	116	6
Canada Goose	8,478	1,211	24
Mute Swan	150	30	5
Mallard	24	2	5
American White Pelican	224	32	1
Double-crested Cormorant	18,774	1,341	4
Other Birds (7 spp.)[2]	9	1	3
Total	**59,999**	**4,928**	**26**
EGG SHAKING			
Common Raven	2	N/A	1
Total	**2**	N/A	1
GRAND TOTAL	**60,001**	**4,928 (38.5 gal.)**	**27**

1 – Numbers of ounces of corn oil used was estimated at 14 eggs oiled per ounce of corn oil (~2mL) for birds similar in size to chickens (gulls, mallards, cormorants, and other), which is slightly more than the 2mL/egg used by Pochop et al. (1998), 4 mL/egg (7 eggs/oz.) for larger birds (goose and pelican), and 6 mL/egg (about 5 eggs/oz.) for swans, based on egg surface areas, which for swans is about 3 times that of a chicken.).

2 - Other bird eggs taken = feral rock dove* (0.4), feral duck* (1.8), feral goose* (2.2), barn swallow (0.8), osprey (2.4), northern harrier (0.6), killdeer (0.8)

* Introduced species

2 HAZARDS

2.1 Human Health and Safety Hazards

Human health and safety hazards associated with the use of egg addling by WS only involves WS personnel. The safety hazards for the individuals treating the eggs are related to the bird's defense mechanisms, which may involve biting, scratching or attacking the nest "predator" with its wings. Based on the target species, the timing (follow-up visits are more likely to have an attack), and sometimes the location such as a park where people are routinely present, the target species may be more likely to attack. Species that typically will attack are Canada geese and swans. Waterfowl that are habituated to people, such as in an urban park, have little fear and may attack more aggressively.

For egg puncturing, additional safety hazards may be associated with using "sharps" such as needles. WS personnel may get injuries, such as cuts, abrasions or punctures, which could expose them to an infectious zoonotic disease, similar to risks faced by health care professionals. These will be discussed in the Risks section below along with incidences of their occurrence.

Additional safety hazards identified for egg oiling, shaking, and puncturing are travel to and from egg nest sites. Vehicular travel has about the same hazards as everyday travel and WS personnel must complete a National Safety Council Defensive Driving Course to drive government vehicles or private vehicles while on-duty (WS Directive 4.150). For waterbirds, travel by boat may be necessary. WS personnel must complete an approved boat safety certification course through the U.S. National Coast Guard, National Association of Boating Law Administrators, or other equivalent to use government-owned or personal watercraft (WS Directive 2.630). Ladders or lifts may be required to gain access to nests and risks for these are described and discussed in "*Chapter 18: The Use of Hand Capture and Disease Sampling in Wildlife Damage Management.*" Vehicles and ladders will not be discussed further. The corn oil used in egg oiling is food grade, which is non-toxic to humans.

2.2 Ecological Hazards

The potential ecological hazards posed by egg addling are minor. Addling is a species-specific method with negligible potential risks to nontarget species. For oiling eggs, WS uses corn oil for oiling eggs, which is nontoxic to species that may come in to contact with it and does not result in bioaccumulation. The only potential for harming nontarget species would be accidentally addling an egg of a nontarget species (misidentifying a nest) or accidentally breaking a nontarget egg while treating target eggs in a colony. Addling eggs in a nesting colony where more than one species is present, but only one is being targeted, could disturb the other species due to the human presence. At times, WS may avoid treating target species in nesting colonies adjacent to sensitive species nests to avoid negative impacts on the sensitive species. However, if treatment is necessary, the disturbance is relatively short lived.

3 RISKS

3.1 Human Health and Safety Risks

WS personnel are at minimal risk of harm from egg addling methods. The common hazards that relate to the use of egg addling for WS personnel are bird bites, scratches, and attacks from wings, which may lead to zoonotic diseases. WS provides wildlife management training on safe wildlife handling for these individuals to minimize their exposure to the safety hazards. The required training includes proper use of personnel protective equipment such as using shields for protection of attacks, and disease safety (WS Directive 2.635).

WS personnel filed an annual average of 79 Office of Workmen's Compensation (OWCP) claims for injuries including animal bites, lacerations and punctures, burns, strained backs, and other injuries for all wildlife management activities that occurred on the job from FY13 to FY15[6]. WS operational field personnel averaged 3 bites or injuries from animals per year. In reference to egg addling, OWCP had no claims or reports of injuries or other maladies related to egg addling from FY13 to FY15. However, individuals handling eggs are trained to be cautious, and are mindful of the parental birds, and surrounding environment. Thus, it has been determined that risks are minimal for WS personnel when addling eggs.

[6] WS started collecting claims records nationally in FY13. Thus, data was only available for a three-year period.

Risks for WS personnel associated with injury from using sharps to puncture eggs would likely be negligible since the method is seldom used and WS implements proactive training measures. From FY13 to FY15, WS personnel reported an average of 3.7 mishaps with sharps annually, but none from puncturing eggs. Sharps-related injuries is a risk concern for health care professionals. The Centers for Disease Control (CDC 2011) estimated that 385,000 sharps-related injuries occur annually in United States hospitals alone, primarily related to syringes and scalpels. Although WS infrequently use egg puncturing, there is potential risk associated with using sharps. WS recently required training for all employees handling sharps to further reduce the risk for wildlife management activities. All WS personnel that use sharps, in collaboration with the APHIS Biosafety Officer, are required to take "Safe Handling and Disposal of Sharps in Laboratory and Field Settings within Wildlife Services" training and adhere to Standard Operating Procedure HS/WS 001.00. Therefore, the risk is considered nonexistent and, at most, negligible to WS personnel using the puncturing.

3.2 Ecological Risks

Ecological risks would primarily result from the unintentional addling of nontarget nesting bird eggs. Risks to nontarget animals is minimal to non-existent as addling is very target specific, only treating the intended species eggs. However, when ground nesting colonies are being treated, as is the case for gulls, it is possible to unintentionally spray or step on nontarget eggs from other species as nests can be relatively non-descript or camouflaged. WS personnel are competent at identifying the target nests and eggs and are cautious when walking around target species nests to avoid taking eggs of nontarget birds. It is highly unlikely that either of these will occur and did not from FY11 to FY15. Additionally, nest abandonment from human presence was not noted to occur and would be highly unlikely because WS personnel are in nesting colonies for only a short amount of time. The primary point of addling, to have the adults continue to sit on the eggs following treatment, would be ineffective if this occurred.

4 UNCERTAINTIES AND CUMULATIVE IMPACTS

Uncertainties for addling eggs are negligible. The primary uncertainty involves whether the eggs being addled have been treated (shaking, puncturing, or oiling) adequately to halt the development of the embryo inside the egg. WS personnel rarely uses shaking or puncturing egg treatments primarily because shaking can be ineffective at times primarily because the WS specialist does not shake the egg hard enough to emulsify the contents and puncturing adds the risk of sharps. However, both can be done effectively. Egg addling has been used as wildlife damage management tool by WS for over 50 years. WS believes that the uncertainty of risk is minimal.

The "Introduction to WS Methods Risk Assessments," Chapter 1 gives all species taken by WS from FY11 to FY15 and shows no significant cumulative impacts from a population standpoint. From a human health perspective, the use of egg addling in wildlife damage management does not have any known cumulative impacts or other unknown risks.

5 SUMMARY

WS uses egg addling to manage birds that cause damage to agricultural, natural resources, or property, or threaten public safety. WS egg addling methods include oiling, shaking, or puncturing, but oiling with food grade corn oil is the most common method used by WS due to its certainty and effectiveness. Shaking is seldom used because it is tedious and less effective than egg oiling. Puncturing was not used by WS between FY11 and FY15, but it is still deemed highly effective. WS takes an annual average of about 60,000 eggs and all but 2 were addled using oiling. WS has several directives guiding their use of addling and handling wildlife. WS use pattern for egg

addling poses negligible risk to WS personnel, the public, and nontarget species. Environmental risks to nontarget animals are insignificant as addling is target species-specific, only treating the intended eggs, and the product, corn oil, is nonhazardous to the environment.

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7 PREPARERS

7.1 APHIS WS Methods Risk Assessment Committee

Writers for "The Use of Egg Addling in Wildlife Damage Management"

Primary Writer: Joshua Hines
Position: USDA-APHIS-WS, Operational Support Staff, Summer Intern 2018
Education: Pursuing BS degree in Biology, Virginia State University

Experience: One year as Secretary for The Minority Association of Premedical Students, Student Ambassador, Student Government Association VP of Finance.

Writer: Thomas C. Hall
Position: USDA-APHIS-WS, Operational Support Staff, Staff Wildlife Biologist, Fort Collins, CO
Education: BS Biology and BA Psychology – Fort Lewis College; MS Wildlife Ecology – Oklahoma State University
Experience: Special expertise in wildlife biology, identification, ecology, and damage management. Thirty-two years of service in APHIS Wildlife Services including operations and research in CO for research and OR, GU, CA, OK, and NV for operations conducting a wide variety of programs including bird damage research and management, livestock protection (predators and birds), invasive species management, wildlife hazard management at airports, property and natural resource protection including waterfowl, brown tree snake, feral swine, rodent, and beaver damage management. Expert in preparing environmental documents for WS programs to comply with the National Environmental Policy Act and the Endangered Species Act. Has used egg addling for Canada goose issues.

Editors for "The Use of Egg Addling in Wildlife Damage Management"

Editor: Michael Green
Position: USDA-APHIS-Wildlife Services (WS), Environmental Coordinator, Fredrick, MD
Education: BS Wildlife and Fisheries Sciences, University of Tennessee
Experience: Special expertise in wildlife biology, ecology, and damage management. Eleven years of work experience with WS in MD and VA. Experienced in a wide range of program activities including nutria eradication, airport wildlife management, and wildlife damage management to protect livestock, aquaculture, public safety, and natural resources. Served as staff biologist in WS Headquarters for two years.

Editor: Andrea Lemay
Position: USDA-APHIS-Policy and Program Development (PPD), Environmental and Risk Analysis Services (ERAS), Biological Scientist, Raleigh, NC
Education: BS Plant and Soil Science (Biotechnology) - University of Massachusetts; MS Plant Pathology -North Carolina State University
Experience: Fourteen years of service in APHIS conducting risk analysis. Four years of experience in preparing environmental analyses in compliance with the National Environmental Policy Act.

Editor: Emily Ruell
Position: USDA-APHIS-WS, NWRC, Registration Specialist, Fort Collins, CO
Education: B.S. Zoology and Biological Aspects of Conservation – University of Wisconsin - Madison; M.S. Ecology – Colorado State University (CSU); M.A. Political Science – CSU
Experience: Three years of experience with WS NWRC preparing and reviewing vertebrate pesticide registration data submissions and other registration materials, and providing pesticide regulatory guidance to WS, WS NWRC, and collaborators. Prior experience before joining APHIS includes seven years of conducting field and laboratory wildlife research at CSU, and environmental policy research for the U.S. Geological Survey.

Editor: Fan Wang-Cahill
Position: USDA-APHIS-Policy and Program Development (PPD), Environmental and Risk Analysis Services (ERAS), Environmental Health Specialist, Riverdale, MD
Education: B.S. Biology and M.S. Hydrobiology - Jinan University, Guangzhou, China; Ph.D. Botany (Ultrastructure/Cell Biology) – Miami University
Experience: Joined APHIS in 2012, preparing human health risk assessments and providing assistance on environmental compliance. Prior experience before joining APHIS includes 18 years environmental consulting experience specializing in human health risk assessments for environmental contaminants at Superfund, Resource Conservation and Recovery Act (RCRA), and state-regulated contaminated facilities.

Editor: Jim Warren
Position: USDA-APHIS-Policy and Program Development (PPD), Environmental and Risk Analysis Services (ERAS), Environmental Toxicologist, Little Rock, AR
Education: B.S. Forest Ecology and M.S. Entomology – University of Missouri; Ph.D. Environmental Toxicology – Clemson University
Experience: Nine years of experience working for APHIS preparing ecological risk assessments and providing assistance on environmental compliance. Prior experience before joining APHIS includes other government and private sector work regarding ecological risk assessments related to various environmental regulations.

Editor: Ryan Wimberly
Position: USDA-APHIS-WS, Operational Support Staff, Staff Wildlife Biologist, Madison, TN
Education: BS Wildlife Management and Ecology – Northwest Missouri State University
Experience: Special expertise in wildlife biology, ecology, and damage management. Eighteen years of service with APHIS Wildlife Services, including operations and research, conducting a wide variety of programs, including bird damage research and management, livestock protection, invasive species management, wildlife hazard management at airports, property, and natural resource protection. Expert in preparing environmental documents for WS programs to comply with the National Environmental Policy Act and the Endangered Species Act.

7.2 Internal Reviewers

USDA APHIS Wildlife Services

Reviewer: Scott Beckerman
Position: USDA-APHIS-WS, State Director/Supervisory Wildlife Biologist, Springfield, IL
Education: BS and MS in Fisheries and Wildlife, University of Missouri-Columbia
Experience: Special expertise in wildlife damage management including using and supervising the use of a variety of net systems to manage damage caused by wildlife. Twenty-five years of service for APHIS Wildlife Services in CA, IL, IA, MO, and WI with experience in managing conflicts with a variety of wildlife including damage caused by white-tailed deer, beaver, invasive birds in industrial and livestock facilities, predators preying on livestock, and wildlife posing hazards to aircraft and human safety at airports.

Reviewer: Travis Guerrant
Position: USDA-APHIS-WS, Asst. State Director/Supervisory Wildlife Biologist, Springfield, IL
Education: BS in Fisheries and Wildlife, University of Missouri-Columbia
Experience: Special expertise in wildlife damage management including using and supervising the use of a variety of net systems in WDM. Thirteen years of service in APHIS Wildlife Services in MO and IL with experience in a wide variety of wildlife damage programs including airports, urban and industrial bird management, deer and beaver damage management, and agriculture protection (beef/swine/dairy farms).

Reviewer: Daniel Hirchert
Position: USDA-APHIS-WS, State Director, Sun Prairie, WI
Education: BS in Field Biology, University of Wisconsin
Experience: Twenty-eight years of service in wildlife damage management with APHIS Wildlife Services and Wisconsin Department of Natural Resources. Expertise in agricultural crop damage, aviation safety, urban wildlife conflicts and natural resource protection.

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 Egg Addling 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 Reviewer Agencies Selected by the Association of Fish and Wildlife Agencies

Arkansas Game and Fish Commission
South Dakota Game, Fish, and Parks
Tennessee Wildlife Resource Agency
Virginia Department of Wildlife Resources

7.3.2 Comments

Peer reviewers provided editorial comments on the manuscript. These were appreciated and incorporated into the final document as appropriate. Following are the comments regarding concerns with the risk assessment and a response:

1. **Comment:** The method risk assessment does provide a list of references, although the citations are somewhat dated and more recent literature may be appropriate.

   Response: We agree, but some of the best literature for this method was from research conducted prior to 2000 when the varying methods were developed.

2. **Comment:** There may be human risks with traveling to these nesting areas sometimes as they may require boat travel to get there or are walking along shorelines of water bodies, etc.—just a FYI to consider

   Response: These are true risks for WS personnel and information was added to Section 2.1 to address the risks. Thank you for the comment as it was an oversight to not address these very real concerns.

3. **Comment:** There is little mention of public perception or reaction to the technique. A quick review of public perception of the technique (or use of this technique by other entities) might add to the MRA.

   Response: Public perception of many of the methods used was discussed in Chapter 1, the Introduction to the risk assessments. Public perception is primary concern for all methods used by WS in wildlife damage management.

4. **Comment:** I'd disagree with this statement in Section 4, "*WS personnel rarely uses shaking or puncturing egg treatments as these tend to be the less effective*.". We've addled thousands of Canada goose eggs via puncturing and had great results. The Summary, Section 5, has a statement that puncturing is highly effective.

   Response: This was a mischaracterization and we agree. Puncturing is very effective as an addling method but adds the risk of sharps. Shaking can be effective but relies on the implementer to do it appropriately (it takes a certain feel to know you have addled the egg). We changed the statement to reflect this oversight.

5. **Comment:** The data used for the risk assessment, FY11-FY15, is old. Is more recent data available?

   Response: Data for FY16-FY20 has been compiled. For FY16-FY20 (Appendix 1 Table 1.1), egg take decreased for most species except American white pelicans, mute swans, and mallards. The overall number of eggs taken, number of species, and corn oil used decreased. The number of states where addling was used increased. Overall, it is within the scope of the document because numbers are lower and less corn oil was used.

Comments were received that did not require a response. We appreciate these comments.

1. **Comment:** The document is thorough, and the writing is mostly clear.

2. **Comments:** The method risk assessment is concise and relatively complete in its description of the egg addling technique and its evaluation. Overall, the method risk assessment provides an efficient

and informative review of the egg addling technique and its use by WS. Egg addling procedures of oiling, shaking, and puncturing were thoroughly described where an individual could read and repeat this process with minimal training required.

3. **Comment:** The method risk assessment presents some good general information on bird reproduction and egg-laying and provides a background for the use of the technique.

4. **Comment:** The method risk assessment provides a sufficient summary of the number of nests/eggs treated and addresses the impacts on these bird populations.

5. **Comment:** The method risk assessment adequately addresses ecological impacts and potential effects on nontarget species. Risk of treating nontarget species or stepping on eggs in colony nests appears to be minimal.

7. **Comment:** I believe this document is well written, describing egg laying/incubation, methods of egg addling, and any potential hazards or risks to personnel conducting the procedures, environment, and non-target species.

8. **Comment:** WS employee extensive previous history (50 years) utilizing the oiling method appears to be the most efficient and effective among the 3 with good documentation. The document well describes there is no additional safety hazards with using 100% corn oil as it is non-toxic to humans, wildlife and environment.

9. **Comment**: The references well support the method risk assessment.

10 **Comment:** Egg puncturing has the most human risk associated among the 3 procedures, but WS employees are required to complete training with use of sharps to further reduce potential injuries.

Appendix 1. WS Egg Addling Take for FY16-FY20.

Table 1.1. The annual average take of target bird eggs with addling by WS in wildlife damage management throughout the United States for FY16-FY20.

ANNUAL AVERAGE EGGS OILED/ADDLED BY WS FOR FY16 TO FY20			
Species	**Eggs**	**Estimated Corn Oil (oz.)[1]**	**No. States**
EGG OILING			
Canada Goose	6,892	985	29 + DC
Mute Swan*	336	67	4
Mallard	51	4	8
Mourning Dove	0.4	0.03	1
Black-necked Stilt	2	0.1	1
American Avocet	5	0.4	1
Killdeer	3	0.2	2
Laughing Gull	2,249	161	1
Ring-billed Gull	17,995	1,285	6
Herring Gull	1,161	83	6
Glaucous-winged Gull	963	69	1
Great Black-backed Gull	17	1	1
American White Pelican	1,039	148	1
Double-crested Cormorant	9,188	656	4
Osprey	1	0.1	1
American Robin	1	0.1	1
Total	**39,903**	**3,460**	
EGG SHAKING			
Canada Goose	1	N/A	1
Canvasback	1	N/A	1
Total	**2**	N/A	2
GRAND TOTAL	**39,905**	**3,460 (27 gal.)**	**35 + DC**

1 – Numbers of ounces of corn oil used was estimated at 14 eggs oiled per ounce of corn oil (~2mL) for birds similar in size to chickens (gulls, mallards, cormorants, and other), which is slightly more than the 2mL/egg used by Pochop et al. (1998), 4 mL/egg (7 eggs/oz.) for larger birds (goose and pelican), and 6 mL/egg (about 5 eggs/oz.) for swans, based on egg surface areas, which for swans is about 3 times that of a chicken.).

* Introduced species