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

Chapter XXIX

USE OF MINIMUM RISK PESTICIDES IN WILDLIFE DAMAGE MANAGEMENT

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EXECUTIVE SUMMARY

Minimum risk pesticides (MRPs) are a specific group of substances that the U.S. Environmental Protection Agency (USEPA) has determined pose little to no risk to human health or the environment and are used in preventing, destroying, repelling, or mitigating pests. MRPs that meet the requirements under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 25(b) and 40 CFR 152.25(f) are exempt from the requirement for federal registration with USEPA. However, the pesticide laws in many states still require registration of MRPs by the state pesticide regulatory agency before distribution and use in that state.

If a pesticide product does not meet all exemption criteria under 40 CFR 152.25(f), then registration is required with USEPA unless the pesticide product is otherwise exempt from registration requirements. For example, when MRP active ingredients are combined with any substances not allowed in MRPs under 40 CFR 152.25(f) (active or inert ingredients), the product requires federal registration under FIFRA. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) discussed MRP active ingredients that are contained within registered pesticides in the Registered Chemical Repellents Risk Assessment (Chapter XXIV) and Egg Addling Risk Assessment (Chapter XVI).

USDA APHIS Wildlife Services (WS) uses or may use MRPs to reduce bird conflicts and damage to crops and property and reduce mammal damage to gardens, crops, trees, and property. Many MRPs mitigate pests by altering the pest's behavior (e.g., a repellent), but some may be used as toxicants or contraceptives for pests. Flocking passerine bird species such as European starlings, blackbirds, and flocking waterbirds, such as gulls, Canada geese, and cormorants, are the primary target bird species WS repel or control with MRPs. WS also uses MRPs to repel pest mammal species like feral house cats, white-tailed deer, and rabbits.

APHIS evaluated the potential human health and ecological risks from the proposed WS use of the MRP active ingredients cloves, corn oil, dried blood, garlic and garlic oil, potassium sorbate, putrescent whole egg solids, sodium lauryl sulfate, and thyme oil. WS does not anticipate adverse human health effects from their use of MRPs based on the FIFRA Section 25(b) requirements for MRPs, the WS use pattern, and the lack of significant human health and environmental hazards posed by the MRP active ingredients. Adherence to WS personal protective equipment requirements minimizes potential exposure to workers.

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GLOSSARY OF TERMS AND ABBREVIATIONS

µg	Microgram
bw	Body weight
CAS	Chemical Abstract Service
EC_{50}	Median effect concentration. A statistically derived concentration of a substance that can be expected to cause an effect in 50% of test organisms. It is usually expressed as a weight of a substance per weight or volume of water or air, e.g., mg/L.
FDA	Food and Drug Administration
FY	The federal Fiscal Year, which is October 1 – September 30.
g	Gram
GRAS	Generally Recognized as Safe
kg	Kilogram
kg-bw	Kilogram of body weight
lb	Pound
L	Liter
LC_{50}	Median lethal concentration. A statistically derived concentration of a substance that can be expected to cause death in 50% of test animals. It is usually expressed as a weight of a substance per weight or volume of water, air or feed, e.g., mg/L, mg/kg-bw.
LD_{50}	Median lethal dose. A statistically derived single dose that can be expected to cause death in 50% of the test animals when administered by the route indicated (oral, dermal, inhalation). It is expressed as a weight of substance per unit weight of animal, e.g., mg/kg.
mg	Milligram
mm Hg	Millimeter of mercury
NOAEL	No observed adverse effect level. The highest dose level of a substance that under defined conditions of exposure causes no observable/detectable adverse effect.
OPP	Office of Pesticide Programs, USEPA
PPE	Personal protective equipment
Tolerance	Maximum amount of pesticide residues allowed on or in food or feed.

USEPA	U.S. Environmental Protection Agency
WDM	Wildlife damage management
WT	Work tasks
w/w	Weight by weight

1 INTRODUCTION

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) employees conduct wildlife damage management (WDM) activities, which include the use of Minimum Risk Pesticides (MRPs) as WDM tools. Pesticides are substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest according to Section 2(u) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). MRPs are pesticides that the U.S. Environmental Protection Agency (USEPA) has determined pose little to no risk to human health or the environment. MRPs that meet the requirements under FIFRA Section 25(b) and 40 CFR 152.25(f) are exempt from the requirement for federal registration with USEPA prior to distribution, sale, and use. Exemption of these products reduces the cost and regulatory burden on businesses and the public for pesticides posing little or no risk.

To qualify as exempt from the requirements for federal registration with USEPA, MRPs must meet the following six conditions specified by USEPA (2023a): 1) only contain active ingredients listed in 40 CFR 152.25(f)(1); 2) only contain inert ingredients listed in 40 CFR 152.25(f)(2), commonly consumed food items in 40 CFR 180.950(a), animal feed items in 40 CFR 180.950(b), edible fats and oils in 40 CFR 180.950(c), or substances listed under 40 CFR 180.950(e); 3) list all ingredients by label display name and list the active ingredients' percentages by weight on the product label; 4) the product labeling cannot claim to control or mitigate organisms that pose a threat to human health or insects or rodents carrying specific diseases; 5) provide the name and contact information of the producer on the label; and 6) the labeling cannot contain any false or misleading statements. Some MRP products cannot be applied to growing or edible portions of agricultural crops because the product may damage the crop, make the plant unpalatable for human consumption, or if one or more of the ingredients are not approved for food or feed uses.

Each state has statutes and regulations for pesticides, including requirements for the registration, distribution, sale, and use of MRPs. Many state pesticide laws require state registration of MRPs before distributing or selling an MRP in their state. In states requiring state registration of MRPs, WS may use MRPs already registered or register additional MRPs with the state for their WDM activities. Under FIFRA and many state pesticide laws, the term "distribute or sell" regarding a pesticide includes the application of a pesticide by an applicator to someone else's property (i.e., providing a service of controlling pests using a pesticide substance) (USEPA 2009a).

MRPs come in various commercial "ready-to-use" and concentrate products and are labeled in accordance with 40 CFR 152.25(f) and state pesticide laws and regulations in the states where state registration is required. MRPs are classified as general-use pesticides by USEPA, which can be applied without a certified applicator license in most states and U.S. territories. However, some states and territories require commercial and public pesticide applicators are licensed by the state before applying general-use products on other public property.

WS may use MRPs to manage wildlife that cause damage to property, agriculture, and natural resources or are potential threats to public safety. WS uses MRP repellents similarly to federally registered chemical repellents to prevent damage to gardens, crops, trees, and property from pest mammals and birds. Federally registered chemical repellents are covered in another risk

assessment[1]. The successful application of MRP repellents to target specific pest animals requires knowledge that 1) MRPs are often, but not always, used to deter animal activity while not causing permanent harm or injury to animals and may require continual training with populations that turn over frequently; 2) the target animal has the sensory abilities to detect and respond to the MRP's active ingredient(s); and 3) MRPs are exempt from the requirement for federal registration under Section 25(b) of FIFRA and meet any other federal and state regulatory requirements for pesticides.

In recent years, WS has used or distributed MRP products containing the following active ingredients: cloves (flower buds of *Syzygium aromaticum*), corn (*Zea mays*) oil, dried blood, garlic (*Allium sativum*) or garlic oil, potassium sorbate, putrescent whole egg solids (i.e., egg solids), sodium lauryl sulfate (SLS), and thyme (*Thymus* spp.) oil. The primary target bird species WS controlled or repelled with these MRPs were flocking passerine bird species (e.g., European starlings[2] and blackbirds[3]), gulls, waterfowl, and double-crested cormorants. White-tailed deer, rabbits, and feral cats were the primary target mammal species.

A few MRPs are used in the population control of particular wildlife. One MRP that WS has used is SLS, an avian wetting agent used to manage flocking starling and blackbird species in roosts via a spray system (USDA 2021). When applied to birds during low temperatures (less than 5°C or 41°F) and sufficient precipitation, SLS allows water to penetrate and saturate their feathers so that treated birds die of hypothermia. (USDA 2021). Another WDM method WS applies is egg oiling (corn oil), primarily used for waterbirds. Corn oil is applied to eggs in individual nests with a cloth or sprayer to clog egg pores, which prevents oxygen from entering the egg and asphyxiates the developing embryo (USDA 2001). Egg addling by egg oiling as a WDM tool was discussed in the Egg Addling Risk Assessment[4] in addition to two other mechanical egg addling methods. The risk assessment primarily discussed using corn oil as a WDM method but did not evaluate corn oil's human health and ecological risks.

This human health and ecological risk assessment provides a qualitative evaluation of risks and hazards of the MRPs WS proposes to use on human health and the environment, including nontarget fish and wildlife. The methods used to assess potential human health effects follow standard regulatory guidance and methodologies (National Research Council 1983) and generally conform to other Federal agencies such as the USEPA (USEPA 2022a). The methods used to assess potential ecological risk to nontarget fish and wildlife generally follow USEPA (2022a) methodologies.

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[1] Risk assessment on the use of registered chemical repellents in wildlife damage management is found at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments.
[2] Scientific names are given in the Risk Assessment Introduction Chapter I, unless first time used.
[3] Generic use of blackbirds for this risk assessment includes specific species of blackbirds, cowbirds, and grackles.
[4] Risk assessment on the use of egg addling in wildlife damage management is found at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments.

1.1 WS Use Pattern

The primary formulations that WS used in FY16-FY20 are given in Table 1, providing the quantity of each MRP applied and distributed and the associated number of work tasks. Data for FY11-FY15 are provided in Appendix 1.

During FY16 – FY20, WS used MRPs in 33 states. The most common MRP used was corn oil to addle an annual average of 39,903 eggs of gulls, double-crested cormorants, Canada geese, American white pelicans, and other bird species (Table 2). Sodium lauryl sulfate was used in Washington to manage starling damage by removing an annual average of 1,480 starlings. WS also applied Bonide® Repels-All granules and Liquid formulations to repel feral cats and Liquid Fence to repel deer and rabbits. WS State Offices and personnel also provide the public with some MRP products for their own use, mostly in cooperation with state agencies that manage game animals, such as white-tailed deer, to lessen problems for farmers and property owners from their damage. Of the 20 average annual work tasks (WTs) associated with distributing repellents from FY11 – FY20, WS responded to public requests involving white-tailed deer (94.1% of WTs), Canada geese (2.9%), eastern cottontail rabbits (1%), house sparrows (1%), woodchucks (0.5%), and wild turkeys (0.5%).

WS uses or distributes the MRP active ingredients covered in this risk assessment: corn oil, cloves, dried blood, putrescent whole egg solids (aka, egg solids), garlic/garlic oil, potassium sorbate, SLS, and thyme oil. A problem formulation, dose-response assessment, exposure assessment, and risk characterization are provided below for each registered active ingredient used or potentially used by WS in the future. The problem formulation section covers each registered active ingredient's chemical description, product use, physical and chemical properties, environmental fate, and hazard identification. Environmental fate describes how chemicals move and degrade in the environment. The environmental fate processes include 1) persistence, degradation, and mobility in soil; 2) movement to air; 3) migration potential to groundwater and surface water; 4) degradation in water; and 5) plant uptake.

The dose-response assessment section discusses the dose levels (toxicity criteria) for potential human health effects, including acute and chronic toxicity. It also discusses available ecological effects data for terrestrial and aquatic species. Available acute and chronic toxicity data are summarized for all major taxa. This data will be integrated with the exposure analysis section to characterize the risk of chemical repellents to nontarget species. This section gathered information from online databases and searches for relevant peer-reviewed and other published literature.

Unless otherwise specified, the toxicity of the technical active ingredient for nontarget mammals and birds was assumed to be similar to the toxicity of the end-use formulations, which is a conservative approach. The toxicity of degradants and metabolites of the chemical repellents to nontarget species are unknown but are assumed to be similar to the parent chemicals for this risk assessment.

Table 1. The annual average number of gallons or pounds of minimum risk pesticides (MRPs) applied or distributed by APHIS-WS in WDM activities in FY16 – FY20 and the number of work tasks (WTs) associated with the applications or distributions.

Active Ingredient(s) (%w/w, CAS Number)	**Product**	**Applied (gal/lb)**	**WTs**	**States Used**	**Distributed (gal/lb)**	**WTs**	**States Used**
Putrescent Whole Egg Solids (1.12%; 51609-52-0) Cloves (0.54%; N/A) Garlic Oil (0.03%; 8000-78-0)	Shot-Gun® Repels-All® (granules, Bonide® Products LLC)	1.8 lb	1	PA	0.6 lb	1	PA
Putrescent Whole Egg Solids (1.01%; 51609-52-0) Cloves (0.05%; N/A) Garlic Oil (0.02%; 8000-78-0)	Shot-Gun® Repels-All® (liquid, Bonide® Products LLC)	0.5 gal	1	PA	-	-	-
Putrescent Whole Egg Solids (1.040%; 51609-52-0) Garlic (0.374%; N/A) Sodium Lauryl Sulfate (0.040%; 151-21-3) Potassium Sorbate (0.495%; 24634-61-5) Thyme Oil (0.010%; 8007-46-3)	Liquid Fence® Deer & Rabbit Repellent (liquid, The Liquid Fence Co., now Spectrum Brands, Inc.)	1 gal	1	NH	2.2 gal	3.2	NH
Dried Blood (12.0%; 68911-49-9)	Plantskydd® Repellent (liquid, Tree World® Plant Care Products Inc.)	-	-	-	0.6 gal	2.4	NH
Dried Blood (100%; 68911-49-9)	Plantskydd® Repellent (powder concentrate, Tree World® Plant Care Products Inc.)	-	-	-	63.8 lb	7	NH/WI
Sodium Lauryl Sulfate (28–30%; 151-21-3)	Multiple	7.8 gal	2.2	WA	-	-	-
Corn Oil (100%; 8001-30-7)	Multiple	35 gal	722	32*	-	-	-

*See Table 2 for specifics of corn oil applications, including species and states used.

Table 2. The annual average number of eggs treated, amounts of corn oil applied, and the number of states for each target bird species in WDM activities by APHIS-WS in FY16 – FY20.

Species	Eggs	Estimated Corn Oil (oz)[1]	States Used
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**	**-**

[1] Ounces of corn oil used was estimated at 14 eggs oiled per ounce of corn oil (~2 mL) for birds similar in size to chickens (gulls, mallards, cormorants, and other), which is slightly more than the 2 mL/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 three times that of a chicken).

* Introduced species

The exposure assessment section evaluates the potential for exposure of humans to the chemical repellents WS applies. The exposure assessment begins with the WS use pattern for chemical repellents. An exposure pathway for chemical repellents includes (1) a release from a chemical repellent source, (2) an exposure point where contact can occur, and (3) an exposure route such as ingestion, inhalation, or dermal contact by which contact can occur. Exposures for the identified human populations are evaluated qualitatively for each identified exposure pathway. Risks associated with adverse human health are characterized qualitatively in this section. The ecological exposure potential and risk characterization for each repellent are also discussed. In cases where data is lacking, USEPA assumes that avian toxicity data is representative of reptiles and terrestrial-phase amphibians, and fish toxicity data is representative of aquatic-phase amphibians.

2 CLOVES

2.1 Problem Formulation

2.1.1 Chemical Description and Product Use

Cloves (CAS number N/A) are the aromatic dried flower buds of the evergreen tree *Syzygium aromaticum*, native to Southeast Asia. Clove oil can be produced from the tree's flower buds or other plant parts (e.g., leaves, stems). Clove oil's primary constituent is the terpenoid eugenol

(CAS number 97-53-0). Cloves and clove oil have a sharp phenolic smell and strong acrid taste that work to deter and prevent feeding by some species of mammals (rabbits and deer).

The MRP products that WS uses containing cloves include other MRP active ingredients in their formulation, which are covered separately in this risk assessment. WS may use and distribute MRP products containing cloves to cooperators to deter herbivores from browsing.

2.1.2 Physical and Chemical Properties

Clove powder is light tan to brown in color, while clove oil is colorless to pale yellow. Clove oil and powder have a sharp odor and are insoluble in water. Clove oil has a boiling point of 251°C (Sigma-Aldrich Corporation 2023b). It has a vapor pressure of 4.91×10^{-6} mm Hg (Baker et al. 2018). Clove oil has a density of 1.038 – 1.060 g/cm^3 at 25°C (Merck 2023). It has an octanol/water coefficient of log K_{ow} of 0.99 (Baker et al. 2018).

2.1.3 Environmental Fate

Cloves and clove oil have a soil half-life of 21.5 hours, an air half-life of 0.01 hours, and a water half-life of 78.4 hours, indicating low to no environmental persistence (Baker et al. 2018).

2.1.4 Hazard Identification

Cloves and their derivatives, including clove oil, are classified as Generally Recognized as Safe (GRAS) by the U.S. Food and Drug Administration (FDA) when used as food additives (21 CFR 184.1257). Cloves and clove oil are exempt from the requirement of a tolerance in or on all food and feed crops when used as a pesticide active ingredient or inert ingredient under 40 CFR 180.1164(d) because it is considered a commonly consumed food commodity (Baker et al. 2018).

A National Pesticide Information Center (NPIC) database review identified 19 reported incidents associated with clove and clove oil use between 1996 and 2016, or about one annually. None of the incidents were serious, and most involved formulated products with multiple ingredients (Baker et al. 2018).

2.2 Dose-Response Assessment

2.2.1 Human Health Dose-Response

Acute Toxicity

Clove and clove oil have low to no toxicity to mammals through all routes of exposure (Table 3).

Cloves and clove oil have minimal to no human health hazards. In closed-patch tests on human skin, clove bud oil applied at a rate of 20% weight by weight (w/w) in Vaseline or ointment caused primary irritation or erythema in 2 out of 25 human subjects. However, 2% and 5% clove bud oil did not cause any reactions in human subjects (Opdyke 1975a;b). Cloves are a commonly consumed food commodity with a significant history of human exposure, demonstrating minimal toxicity.

Table 3. Acute oral median lethality studies for mammals for cloves and clove oil.

Test Species	Test	Result	USEPA Toxicity Category	Reference
Albino Wistar Rat (male)	Acute Oral LD_{50}	Flower oil: 3,598 mg/kg-bw	III	(Shalaby et al. 2011)
Laboratory Brown Rat	Acute Oral LD_{50}	Leaf oil: 1,370 mg/kg-bw	III	(Opdyke 1978)
Laboratory Brown Rat	Acute Oral LD_{50}	Bud oil: 2,650 mg/kg-bw	III	(Opdyke 1975a)
Laboratory Brown Rat	Acute Oral LD_{50}	Stem oil: 2,020 mg/kg-bw	III	(Opdyke 1975b)
Domestic Rabbit	Acute Dermal LD_{50}	Leaf oil: 1,200 mg/kg-bw	III	(Opdyke 1978)
Domestic Rabbit	Acute Dermal LD_{50}	Bud oil: >5,000 mg/kg-bw	IV	(Opdyke 1975a)
Domestic Rabbit	Acute Dermal LD_{50}	Stem oil: >5,000 mg/kg-bw	IV	(Opdyke 1975b)
Domestic Rabbit	Primary Dermal Irritation	Moderately irritating	III	(Opdyke 1975a;1978)
Laboratory Mouse	Primary Dermal Irritation	Not irritating to severely irritating	II-IV	(Opdyke 1975a;1978)

Subchronic and Chronic Toxicity

Albino male Wistar rats gavaged with clove oil at 10% of the LD_{50} (~360 mg/kg-bw) for one month were found to have liver inflammation and renal corpuscular tubules that were convoluted and hemorrhaging in the interstices of the kidneys (Shalaby et al. 2011).

No chronic toxicity studies of clove and clove oil were found.

Developmental and Reproductive Effects, Neurotoxicity Effects, Carcinogenicity and Mutagenicity, Immunotoxicity Effects, and Endocrine Effects

Cloves and clove oil are not classified as carcinogens by the International Agency for Research on Cancer (IARC) (IARC 2023). Prenatal developmental toxicity studies showed no difference between treated and control groups of rats, mice, hamsters, and rabbits (Baker et al. 2018). Clove oil is highly cytotoxic to human fibroblasts at concentrations as low as 0.03% w/w. The cytotoxic effect is attributed to eugenol, the main chemical component of clove oil (Prashar et al. 2006).

2.2.2 Ecological Effects Dose Response

Aquatic Effects Analysis

Clove oil is slightly toxic to freshwater fish and aquatic invertebrates (Table 4).

Table 4. Acute and chronic toxicity to aquatic vertebrates and invertebrates for clove oil.

Taxonomic group	Test species	Test	Result	Reference
Freshwater Fish	Rainbow trout (*Oncorhynchus mykiss*)	10-min LC_{50}	81.1 mg/L	(Velisek et al. 2005a)
Freshwater Fish	Rainbow trout (*Oncorhynchus mykiss*)	30-min LC_{50}	65.0 mg/L	(Velisek et al. 2005a)
Freshwater Fish	Rainbow trout (*Oncorhynchus mykiss*)	24-hr LC_{50}	61.5 mg/L	(Velisek et al. 2005a)
Freshwater Fish	Carp (*Cyprinus carpio*)	96-hr LC_{50}	74.3 mg/L	(Velisek et al. 2005b)
Freshwater Fish	Zebrafish (*Danio rerio*)	96-hr LC_{50}	18.2 mg/L	(Doleželová et al. 2011)
Freshwater Fish	Guppy (*Poecilia reticulata*)	96-hr LC_{50}	21.7 mg/L	(Doleželová et al. 2011)
Freshwater Invertebrates	Gammarus (*Gammarus minus*)	EC_{50}	>14.7 µl/ml	(Venarsky and Wilhelm 2006)

Terrestrial Effects Analysis

No acute oral median lethality or subacute dietary toxicity studies for mammals or birds were found for cloves or clove oil. Clove oil was not toxic to western honey bees (*Apis mellifera*) at a dose of 1 mg/bee over a 48-hr period (Lindberg et al. 2000). In another study, the 8-day oral LD_{50} for clove oil was estimated to be reached with a 7,800 ppm solution. The 14-day oral LD_{50} was estimated to be reached with a 240 ppm solution for honey bees (Ebert et al. 2007). The American Society for the Prevention of Cruelty to Animals Animal Poison Control Center reported that between 2006 and 2008, 39 cats and nine dogs were involved in exposure incidents with flea products that contained clove oil and other active ingredients exempt from federal registration (Genovese et al. 2012). Symptoms included skin erythema, vomiting, diarrhea, lethargy, edema, ataxia, seizures, weakness, recumbent tachycardia, agitation, anorexia, hyperactivity, hypersalivation, panting, retching, tremors, vocalization, and renal failure. Clove oil can be used as an herbicide and exhibits phytotoxicity. Studies have shown leaf injury to dandelion (*Taraxacrum officinale*) at a 2% w/w concentration (Tworkoski 2002) and 8% w/w concentrations of clove oil caused plant injury to common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemesiifolia*), and johnsongrass (*Sorghum halepense*) (Tworkoski 2002). No studies on the effects on nontarget plants were found.

2.3 Exposure Assessment and Risk Characterization

2.3.1 Human Health Exposure and Risk Characterization

The annual amount of cloves that WS uses in its wildlife damage management program is limited (Table 1). Between FY16 and FY20, WS only used an average of 1.8 pounds of MRPs containing 0.54% w/w of the active ingredient cloves. Cloves pose little to no risk to human health from this use. Applications of products containing cloves as active ingredients applied according to label instructions should not result in harm to the general population or applicators. Due to the low toxicity of cloves and clove oil to humans or mammals, the low volumes of MRP products

containing cloves that WS uses, and the training of WS applicators in the proper use of personal protection equipment (PPE) and pesticides, the risks to WS applicators or the public from WS use or distribution of MRP repellent products containing cloves are negligible.

2.3.2 Ecological Exposure and Risk Characterization

Cloves pose little to no risk to the environment. WS applicators adhere to label requirements, which include not applying the product directly to water. Based on the limited use, small quantities of cloves in the formulated products, the lack of toxicity, and the environmental fate properties, WS use of formulated products containing cloves will not harm nontarget terrestrial and aquatic species.

3 CORN OIL

3.1 Problem Formulation

3.1.1 Chemical Description and Product Use

Corn oil (CAS number 8001-30-7) is a commonly consumed food ingredient (21 CFR 101). Corn oil is extracted from corn kernels of corn plants, usually using a wet milling process (Baker and Grant 2018a). Corn oil is primarily composed of the glycerides of linoleic acid (34 – 62% w/w), followed by oleic acid (19 – 49% w/w), palmitic acid (8 – 12% w/w), stearic acid (2.5 – 4.5% w/w), and hexadecenoic and myristic acids (0.1 – 1.7% w/w each) (Merck 2023). Corn oil is highly digestible (Baker and Grant 2018a). In addition to being an MRP active ingredient, corn oil is an inert commodity ingredient in registered pesticides (USEPA 2023d).

WS may use MRP products containing 100% w/w corn oil to addle eggs of pest bird species, primarily waterbirds (Tables 1 and 2). Corn oil is applied to the surface of pest bird species eggs during incubation, which closes the eggshell's surface pores and asphyxiates the developing embryo (Baker and Grant 2018a, USDA 2001). Additional information on the uses of corn oil for egg addling is available in the Egg Addling Risk Assessment.

3.1.2 Physical and Chemical Properties

Corn oil is a yellow liquid with a characteristic corn odor (Merck 2015). Corn oil solidifies at -18 – -10°C, boils (smokes) at 230 – 238°C, is insoluble in water, and is slightly soluble in alcohol (Merck 2023, NIH 2023a). Corn oil has a density of 0.916 – 0.921 g/cm^3 at 25°C (Merck 2023) and a vapor pressure of 3.18x10$^{-11,}$ and an octanol/water coefficient (K_{ow}) of 1.86 (Baker and Grant 2018a).

3.1.3 Environmental Fate

Corn oil has an estimated half-life in soil of 2,880 hours, an estimated half-life in air of 0.276 hours, and an estimated half-life in water of 1,440 hours (USEPA 2024), indicating environmental persistence. Corn oil is readily biodegradable (Baker and Grant 2018a). Tests have indicated that vegetable oils undergo about 70-100% biodegradation in a period of 28 days (Aluyor et al. 2009).

3.1.4 Hazard Identification

Corn oil is a commonly consumed food ingredient (21 CFR 101). Corn oil is exempt from the requirement of a tolerance in or on all food commodities when used as a pesticide active ingredient or inert ingredient under 40 CFR 180.950(c) as an edible oil (Baker and Grant 2018a).

No human health incidents involving corn oil were reported to NPIC between 1996 and 2016 (Baker and Grant 2018a).

3.2 Dose-Response Assessment

3.2.1 Human Health Dose-Response

Corn oil is classified as nontoxic for acute and 90-day oral toxicity (Andersen et al. 2011, Baker and Grant 2018a, Sigma-Aldrich Corporation 2023a). Corn oil causes slight, reversible eye irritation and is a mild dermal irritant, but it is not a skin sensitizer (Andersen et al. 2011, Baker and Grant 2018a, Sigma-Aldrich Corporation 2023a). Corn oil does not cause reproductive or developmental toxicity (Baker and Grant 2018a). Corn oil is classified as an equivocal carcinogen in the Hazardous Substances Database when consumed in relatively high doses (10 ml/kg-bw) (Baker and Grant 2018a).

3.2.2 Ecological Effects Dose Response

No data are available on the ecotoxicity of corn oil. Corn oil is a suffocating oil (physical mechanism of control) when applied to the surface of insects, blocking the insects' spiracles (Baker and Grant 2018a).

3.3 Exposure Assessment and Risk Characterization

3.3.1 Human Health Exposure and Risk Characterization

Corn oil has minimal human health hazards, is a commonly consumed food ingredient, and has a significant history of exposure to humans, demonstrating minimal toxicity (Baker and Grant 2018a). The use of MRP products containing corn oil by WS for egg addling poses minimal to no risk to the general public or WS applicators.

3.3.2 Ecological Exposure and Risk Characterization

WS's low-use volumes for egg addling, the lack of oral toxicity to mammals, and corn oil's biodegradability indicate that MRP repellents containing corn oil pose little to no exposure risk to nontarget terrestrial or aquatic species.

4 DRIED BLOOD

4.1 Problem Formulation

4.1.1 Chemical Description and Product Use

Dried blood (CAS Number 68911-49-9) is produced from clean, fresh bovine or porcine blood obtained from slaughterhouses (USEPA 1991). The raw blood is flash dried, centrifuged, and then thoroughly dried at very high temperatures. Dried blood is the active ingredient in MRP-repellent products for various pest mammals (deer, rabbit, squirrel, vole, elk, moose). Dried blood products can be used to protect agriculture (fruiting trees, nurseries, crops), forestry (Trent et al. 2001),

and personal landscaping and gardens. Dried blood is also a non-food use only inert ingredient in registered pesticides (USEPA 2023d).

Dried blood is a naturally occurring substance and has a nontoxic mode of action. Dried blood can be applied as a perimeter treatment to protect an area or as a contact treatment applied directly to the plant (Trent et al. 2001). Formulated products that contain dried blood are 100% w/w dried blood and available in "ready-to-use" granules or liquid formulations. Granules are placed or sprinkled by hand on the ground. Liquid formulations may be sprayed onto the trunks of trees or used as a dip for bulbs or tree whips. WS distributes dried blood products to cooperators experiencing deer and rabbit damage (Table 1).

4.1.2 Physical and Chemical Properties

Dried blood is a black and tan speckled powder with a faint odor (Baker and Grant 2018c). It is stable when stored in sealed containers at ambient temperatures.

4.1.3 Environmental Fate

Dried blood is organic matter that rapidly degrades in the environment.

4.1.4 Hazard Identification

USEPA determined that potential risks to humans from exposure to dried blood pesticide products during application are considered negligible, and the MRP uses of dried blood alone pose no adverse human health effects. The manufacturing process ensures the denaturation of proteinaceous material and inactivation of potential mammalian pathogens (i.e., endogenous or exogenous contaminants) in dried blood used as a repellent (USEPA 1991).

Dried blood does not have a tolerance or an exemption from the tolerance requirement in 40 CFR 180 and cannot be used on food crops (Baker and Grant 2018c). Dried blood is not classified as GRAS by FDA as a food additive. Blood and blood products are excluded from the prohibition of animal-derived protein sources in livestock feed (21 CFR 589.2000) (Baker and Grant 2018c).

The NPIC received 21 reports of human health-related incidents between 1996 and 2016 (Baker and Grant 2018c). Symptoms included headaches, sweating, gagging, nausea, vomiting, and coughing (Baker and Grant 2018c).

4.2 Dose-Response Assessment

4.2.1 Human Health Dose-Response

No toxicity data were available for human health effects. USEPA waived the human health effects data requirements for acute, subchronic, chronic, and developmental toxicity, mutagenicity, and immunotoxicity for registered dried blood pesticides due to its nontoxic properties and the manufacturing process, which ensures the denaturation of proteinaceous material and inactivation of potential mammalian pathogens (i.e., endogenous or exogenous contaminants) in dried blood used as a repellent (USEPA 1991).

4.2.2 Ecological Effects Dose Response

Aquatic Effects Analysis

No data were available. USEPA waived the ecotoxicity data requirements for fish, aquatic invertebrates, and aquatic plants for dried blood during registration review (USEPA 1991).

Terrestrial Effects Analysis

No data were available. USEPA waived the ecotoxicity data requirements for avian, mammal, terrestrial invertebrate, and terrestrial plant toxicity for dried blood during registration review (USEPA 1991).

Dried blood is not considered phytotoxic (USEPA 1991).

4.3 Exposure Assessment and Risk Characterization

4.3.1 Human Health Exposure and Risk Characterization

Dried blood used to produce MRP-repellent products comes from bovine and porcine slaughterhouses (USEPA 1991). The manufacturing process of dried blood products ensures the denaturation of proteinaceous material and the inactivation of potential pathogens (USEPA 1991).

Dried blood MRP repellent products cannot be used on food or feed crops, and dried blood is readily biodegradable in the environment. Therefore, dietary exposures through food and drinking water are negligible (Baker and Grant 2018c).

WS distributes dried blood MRP products to cooperators, which has a negligible risk to applicators or the general public based on their environmental fate properties and low toxicity profile (Table 1). Any potential future use by WS of repellent products containing dried blood would also have negligible risk to the general public or WS applicators.

4.3.2 Ecological Exposure and Risk Characterization

The low-use volumes, use sites, biodegradability, and lack of phytotoxicity or persistence in the environment indicate MRP repellents containing dried blood pose little to no exposure risk to terrestrial species. Furthermore, dried blood is a naturally occurring substance (USEPA 1991). Target pest animals visiting the use sites allowed for these products will be repelled and will avoid further exposure.

The USEPA determined that there will be no effects on nontarget species from the use of registered repellent products containing dried blood when used as directed (USEPA 1991).

5 GARLIC AND GARLIC OIL

5.1 Problem Formulation

5.1.1 Chemical Description and Product Use

Garlic (CAS number N/A) is usually from the bulb of the garlic plant (*Allium sativum*) and is a commonly consumed food. When used in pesticides, dehydrated garlic is ground into a powder or flaked (Baker and Grant 2018b). Garlic oil (CAS number 8000-78-0) is a naturally occurring oil

extract from the bulb and other parts of the garlic plant and is an edible oil. Garlic and its primary active constituent, garlic oil, are volatile and strongly scented. It works to deter and prevent the feeding of some species of mammals, including squirrels, rabbits, and deer (USEPA 2022b). The MRP end-use products used to repel animals have concentrations of garlic oil ranging from 0.001 to 0.12% w/w active ingredient. Garlic oil is currently registered as an active ingredient in 18 federally registered products (USEPA 2022b). The labels for these products interchangeably list the active ingredient as garlic oil, garlic juice, garlic water, or garlic and are water-based compounds with a garlic extract or powder. USEPA considers all such variations of *A. sativum* as garlic oil under the Pesticide Chemical (PC) Code 128827 (USEPA 2010a).

WS may use or distribute MRP repellent products containing garlic or garlic oil to cooperators to deter herbivores from browsing. These MRPs containing garlic and garlic oil include other MRP active ingredients in their formulation, which are covered separately in this assessment. Federally registered products containing garlic oil are covered in another Risk Assessment (Chapter 24 Use of Registered Chemical Repellents in WDM).

5.1.2 Physical and Chemical Properties

Garlic is a white to yellowish-white solid powder or flake (Baker and Grant 2018b). Garlic oil is a light tan to dark green liquid or powder (USEPA 2009b;2022b). Garlic oil has a pungent odor and is partially to fully soluble in water (USEPA 2009b;2022b). Garlic oil has a boiling point of 136.32°C and a vapor pressure of 10 mm Hg at 20°C (Baker and Grant 2018b).

5.1.3 Environmental Fate

Garlic and garlic oil biodegrade rapidly and have low to no persistence in the environment (USEPA 2022b).

5.1.4 Hazard Identification

Garlic and garlic oil are classified as GRAS when used as food additives (21 CFR 182.10, 182.20, and 182.1317). Garlic oil is also exempt from the requirement of a tolerance in or on all food commodities when used as a pesticide active ingredient or inert ingredient under 40 CFR 180.950(a) and (c) because they are a commonly consumed food and edible oil (USEPA 2010a;2022b).

USEPA (2022b) reviewed the Incident Data System and identified 15 reported incidents associated with garlic oil, eight incidents pertaining to human health, six involving domestic animals, and one involving both human health and a domestic animal. None of the incidents were serious, and all the products contained other active ingredients, such as capsaicin and egg solids.

USEPA waived data requirements for quantitative dietary (food and drinking water) exposure due to garlic oils' composition and physical and chemical properties, broad availability for human consumption, and its benefits to human health (USEPA 2022b).

5.2 Dose-Response Assessment

5.2.1 Human Health Dose-Response

Garlic and garlic oil have minimal human health hazards, are commonly consumed food commodities, and have a significant history of human exposure, demonstrating minimal toxicity (USEPA 2022b).

5.2.2 Ecological Effects Dose Response

No ecotoxicity data for garlic or garlic oil are available for mammals or birds. Garlic oil is practically nontoxic to cabbage looper (*Trichoplusia ni*) larvae with an acute contact LD_{50} of 22.7 µg/insect (Machial et al. 2010). USEPA (2022b) concluded garlic oil would not result in a hazard or toxic risk to nontarget organisms and waived all nontarget organism and environmental fate data requirements for garlic oil due to garlic oils' natural occurrence, nontoxic mode of action as a repellent, and biodegradability.

USEPA (2022b) reviewed the Incident Data System and identified four reported incidents associated with garlic oil. These incidents included minor exposure and damage to plants, although it is unclear if the damage resulted from garlic oil as the products also contained capsaicin and egg solids.

5.3 Exposure Assessment and Risk Characterization

5.3.1 Human Health Exposure and Risk Characterization

USEPA (2022b) concluded that applications of registered products containing garlic oil according to label instructions would not result in harm to the general population or applicators, which is likely to be true for MRP products as well. USEPA has not yet assessed garlic oil under their Endocrine Disruptor Screening Program (USEPA 2022b).

Due to the low toxicity of garlic or garlic oil to humans or mammals, the low volumes of MRP products containing garlic or garlic oil that WS uses, and the training of WS applicators in the proper use of PPE and pesticides, the risks to WS applicators or the public from WS use or distribution of MRP repellent products containing garlic and garlic oil are negligible.

5.3.2 Ecological Exposure and Risk Characterization

The lack of toxicity and the environmental fate properties of garlic and garlic oil combined with the low concentrations of garlic and garlic oil in MRP products used by WS indicate WS use or distribution of MRP products containing garlic and garlic oil will not harm nontarget terrestrial or aquatic species.

6 POTASSIUM SORBATE

6.1 Problem Formulation

6.1.1 Chemical Description and Product Use

Potassium sorbate (chemical formula $C_6H_7KO_2$; CAS number 24634-61-5; synonyms: sorbic acid, potassium salt, potassium salt of sorbic acid, and potassium (2E,4E)-hexa-2,4-dienoate); is a naturally occurring compound in foods (fruits and berries) (ACS 2023, Baker and Grant 2018f).

Potassium sorbate is synthetically produced by mixing sorbic acid (CAS number 10-44-1) with potassium hydroxide (USEPA 2003). Potassium sorbate's primary uses as an MRP active ingredient include fungicide, bactericide, algicide, or insect repellent (Baker and Grant 2018f). In addition to being an MRP active ingredient, potassium sorbate is also an MRP inert ingredient (40 CFR 152.25(f)(2)) and a commodity inert ingredient in registered pesticides (USEPA 2023d). All registered pesticide products containing potassium sorbate as an active ingredient were voluntarily canceled in the 1980s for unknown reasons (under CAS number 590-00-1) (USEPA 2023e).

Potassium sorbate is also an active ingredient in an MRP repellent product used or distributed by WS to repel target deer and other mammal species (Table 1). The MRP product that WS uses containing potassium sorbate includes other MRP active ingredients in its formulation, which are covered separately in this assessment. WS may use and distribute products containing potassium sorbate to cooperators to deter herbivores from browsing.

6.1.2 Physical and Chemical Properties

Potassium sorbate is a white, crystalline solid highly soluble in water (Baker and Grant 2018f, USEPA 2003). Potassium sorbate has a density of 1.363 g/cm^3 at 25°C, a melting point of 270°C, and a boiling point of 446°C (Baker and Grant 2018f, USEPA 2003). Potassium sorbate has a vapor pressure of <0.01 mm Hg at 20°C and a log K_{ow} of -1.72 at a pH of 6.5 and 1.32 at a pH of 2.5 (Baker and Grant 2018f, ECHA 2013, USEPA 2003).

6.1.3 Environmental Fate

Potassium sorbate disassociates in solution to ionic potassium and its free acid, sorbic acid (Baker and Grant 2018f). Potassium sorbate has a half-life in soil of 416 hours, a half-life in the air of 2.6 hours, and a half-life in water of 208 hours (Baker and Grant 2018f), indicating low to no persistence in the environment. Potassium sorbate, its free acid, and sorbic acid are readily biodegradable in the environment and do not bioaccumulate in aquatic organisms (ECHA 2013, USEPA 2003).

6.1.4 Hazard Identification

Potassium sorbate is classified as GRAS when used as a food additive (21 CFR 182.3640) and is a commonly used food preservative (USEPA 2003). Potassium sorbate is also exempt from the requirement of a tolerance in or on all food commodities when used as an MRP or registered pesticide inert ingredient under 40 CFR 180.950 and 40 CFR 180.1233 (USEPA 2003).

The NPIC received two reports of human health-related incidents involving potassium sorbate between 1996 and 2016, but both involved other active ingredients in addition to potassium sorbate, and symptoms were not reported (Baker and Grant 2018f). When ingested, a small, undefined subgroup of people may suffer from contact dermatitis, hives, stinging sensations from dermal exposure, and 'burning mouth syndrome' (Baker and Grant 2018f, ECHA 2013). An incident of repeated occupational exposure in a dairy plant that led to severe rashes in an exposed worker was also reported (Baker and Grant 2018f, Le Coz and Abensour 2005).

6.2 Dose-Response Assessment

6.2.1 Human Health Dose-Response

Acute Toxicity

The reported acute oral LD_{50} values for potassium sorbate range from 4,340 to 6,170 mg/kg-bw in rats and 3,800 mg/kg-bw in mice (Toxicity Category III – IV) (Baker and Grant 2018f, USEPA 2003). The only acute inhalation toxicity data for potassium sorbate was for a 50% aqueous solution; based on this study, the acute inhalation of 4-hr LC_{50} for potassium sorbate in rats was >5.15 mg/L (Category IV) (ECHA 2013). Potassium sorbate can cause eye irritation and contact dermatitis but is not a skin sensitizer (ECHA 2013, USEPA 2003).

Subchronic, Chronic, Developmental, and Reproductive Toxicity, Neurotoxicity Effects, Carcinogenicity and Mutagenicity, Immunotoxicity Effects, Endocrine Effects

In 90-day oral toxicity studies on potassium sorbate's free acid and sorbic acid in mice, rats, and dogs, there were no adverse effects observed for mice or dogs at the levels tested, and the NOAEL was 2,500 mg/kg-bw/day in rats (Baker and Grant 2018f, USEPA 2003). Potassium sorbate is expected to be less toxic than sorbic acid (USEPA 2003).

In a developmental toxicity study (oral gavage) with potassium sorbate in rats, the NOAELs for maternal toxicity, embryotoxicity, and teratogenicity were 340 mg/kg-bw/day, which was the highest dose level tested (ECHA 2013). Potassium sorbate is not considered toxic to reproduction (ECHA 2013).

Potassium sorbate is not considered to be genotoxic or carcinogenic, based on a lack of mutagenicity in an Ames assay, a lack of chromosomal aberrations in Chinese hamster (*Cricetulus griseus*) fibroblast cells, and a negative result for a carcinogenicity study in mice. However, results from sister chromatid studies with Chinese hamster lung cells were inconclusive (Baker and Grant 2018f, USEPA 2003). Potassium sorbate is not considered to be a carcinogen by the International Agency for Research on Cancer (Baker and Grant 2018f).

No subchronic, neurotoxicity, or immunotoxicity data was available for the human health effects of potassium sorbate.

6.2.2 Ecological Effects Dose Response

Aquatic Effects Analysis

Potassium sorbate is nontoxic to freshwater fish and aquatic invertebrates (ECHA 2013). The 48-hr EC_{50} (immobilization) is 982 mg/L in the water flea (*Daphnia magna*) (ECHA 2013). The 96-hr LC_{50} is >1,000 mg/L in rainbow trout (ECHA 2013). No other ecotoxicity data were available for aquatic animals or plants.

Terrestrial Effects Analysis

Potassium sorbate is practically nontoxic to mammals based on the acute oral toxicity values in rats (>3,340 mg/kg-bw) and mice (>3,800 mg/kg-bw) (Baker and Grant 2018f, USEPA 2003). No other ecotoxicity data are available for terrestrial animal or plant species.

6.3 Exposure Assessment and Risk Characterization

6.3.1 Human Health Exposure and Risk Characterization

Potassium sorbate has minimal toxicity or other human health hazards and is commonly found in foods and other products (USEPA 2003). Due to the low toxicity of potassium sorbate to humans or mammals, the low volumes used by WS, and the training of WS applicators in the proper use of PPE and pesticides, the risks to WS applicators or the public from WS use or distribution of the MRP repellent product containing potassium sorbate are negligible.

6.3.2 Ecological Exposure and Risk Characterization

The potassium sorbate within the MRP product used and distributed by WS is not likely to result in a hazard or toxic risk to nontarget aquatic or terrestrial organisms, based on the lack of toxicity and the environmental fate properties for potassium sorbate and WS use patterns for the MRP product containing potassium sorbate.

7 PUTRESCENT WHOLE EGG SOLIDS

7.1 Problem Formulation

7.1.1 Chemical Description and Product Use

Putrescent whole egg solids (CAS number 51609-52-0; synonym: egg solids) are simply dried chicken eggs that have been pasteurized and are free of viable pathogens (USEPA 2018). Egg solids repel mammals, primarily from feeding on vegetation, by an aversive odor and taste (USEPA 2018). The FDA considers putrescent whole egg solids as a GRAS chemical when used as a food additive. Putrescent whole egg solids are found in MRPs and several federally registered pesticides (under the active ingredient name egg solids), which USEPA classifies as biopesticides or biochemical pesticide active ingredients (USEPA 2018). Federally registered chemical repellent products containing egg solids are covered in another risk assessment (Chapter 24 Use of Registered Chemical Repellents in WDM). Egg solids are also an inert commodity ingredient in registered pesticides (USEPA 2023d).

MRPs and federally registered products containing putrescent whole egg solids are used in home gardens, nurseries, greenhouses, and forestry plantations, on various fruit and nut trees, and on ornamental woody shrubs (USEPA 2018). Applications are typically applied in dust and liquid forms (USEPA 2018). MRP products containing putrescent whole egg solids can be used before and after flowering. USEPA has established a tolerance exemption for putrescent whole egg solids for pesticide food uses in accordance with the criteria specified in 40 CFR 180.1071. However, federally registered product labels for repellent products do not allow for use on plants intended for human consumption or in fields where drift could occur into fields with plants intended for human consumption because the proteins in putrescent whole egg solids may cause allergic reactions in some people (USEPA 2018;2022c).

The MRP repellent products that WS uses or distributes that contain putrescent whole egg solids include other MRP active ingredients in their formulation (Table 1), which are covered separately in this assessment.

7.1.2 Physical and Chemical Properties

Putrescent whole egg solids are a light brown to beige powder with a malty odor (USEPA 2011b). They are practically insoluble in water (USEPA 2011c).

7.1.3 Environmental Fate

Putrescent whole egg solids are organic matter that rapidly degrades (decomposes) in the environment and is expected to be non-persistent (USEPA 1992).

7.1.4 Hazard Identification

Putrescent whole egg solids are nontoxic to humans. In registered pesticides, egg solids are classified as a biopesticide by USEPA and are considered GRAS by FDA when used as a food additive (USEPA 1992;2018). USEPA waived most of the data requirements for the reregistration of pesticide products containing egg solids, including data for toxicology, residue chemistry, human exposure, and ecological effects and environmental fate (USEPA 2011d).

The odor and taste of putrescent whole egg solids act as a repellent when applied to plants that repel white-tailed deer and other target animals from foraging (USEPA 2018). The target mammals are sensitive to the smell and taste of putrescent whole egg solids; however, the odor is barely detectable to humans (USEPA 2018).

Between 1996 and 2016, 32 human health-related incidents in NPIC involved accidental ingestion and resulted in nausea, inhalation exposures, and eye exposures resulting in eye irritation (Baker and Grant 2018g). USEPA (2018) reviewed the Incident Data System and found one incident report of a person that experienced discomfort after inhaling a product containing egg solids, which was deemed a misuse of the product.

7.2 Dose-Response Assessment

7.2.1 Human Health Dose Response

Acute Toxicity

Putrescent whole egg solids are practically nontoxic on an acute oral, dermal, and inhalation basis (USEPA 2011b). The LD_{50} values for acute oral and dermal toxicity are >5,000 mg/kg-bw (Toxicity Category IV) (USEPA 2011d). The acute inhalation LC_{50} is >2.10 mg/L (Toxicity Category III) (USEPA 2011d). In acute eye irritation studies, putrescent whole egg solids caused corneal irritation, which cleared within 48 hours (Toxicity Category III) (USEPA 2011b). Putrescent whole egg solids are a slight dermal irritant (Toxicity Category IV) and may be a skin sensitizer (USEPA 2011b).

Subchronic and Chronic Toxicity

Data is not available on the subchronic and chronic toxicity of putrescent whole egg solids. USEPA waived these studies for registered products due to the lack of acute toxicity.

Developmental and Reproductive Toxicity, Neurotoxicity Effects, Carcinogenicity and Mutagenicity, Immunotoxicity Effects, Endocrine Effects

USEPA waived these studies for registered products due to the lack of acute toxicity. No reports of adverse effects were submitted to the USEPA, and it is not expected to have adverse effects on humans (USEPA 1992;2011d).

7.2.2 Ecological Effects Dose-Response

Aquatic Effects Analysis

USEPA waived the ecotoxicity data requirements for aquatic species for putrescent whole egg solids because of their low hazard and risk to the environment (USEPA 2011a).

Terrestrial Effects Analysis

USEPA waived the ecotoxicity data requirements for terrestrial species because of the low hazard and risk to the environment from putrescent whole egg solids (USEPA 2011a). USEPA (2011a) concluded putrescent whole egg solids would not result in a hazard or toxic risk to nontarget organisms.

USEPA (2018) reviewed the Incident Data System for reported incidents and determined it unlikely that egg solids used according to their labels would cause adverse effects on the environment. Four incidents for egg solids involved dogs ingesting small amounts of the product, with some experiencing diarrhea and vomiting. Four incidents reported plant damage. From the incidents reported to NPIC between April 1, 1996, and March 30, 2016, accidental ingestion was the main exposure route, with some of the exposed animals vomiting; however, many reported no symptoms (Baker and Grant 2018g).

7.3 Exposure Assessment and Risk Characterization

7.3.1 Human Health Exposure and Risk Characterization

The product labels for registered repellents containing egg solids do not allow applications or drift onto plant parts meant for human consumption. This limits exposure through dietary consumption; putrescent whole egg solids may cause an allergic reaction in some people. USEPA (2011d;2018) concluded that applications of registered products containing egg solids as the active ingredient according to label instructions would not result in harm to the general population or applicators. Similarly, USEPA concluded that registered products containing egg solids that also contain capsaicin, garlic oil, or both will not result in harm to people (USEPA 2009e).

The labels for registered products containing egg solids do not require PPE. Due to the low toxicity of putrescent whole egg solids to humans and other mammals, the low volumes used or distributed by WS, and the training of WS applicators in the proper use of pesticides, the risks to WS applicators or the public from WS use and distribution of MRP repellent products containing putrescent whole egg solids are negligible.

7.3.2 Ecological Exposure and Risk Characterization

Putrescent whole egg solids break down rapidly in the environment, indicating runoff and leaching into water resources would be minimal. WS expects aquatic exposure to putrescent whole egg solids from WS use, and the distribution of MRP products containing putrescent whole egg solids will be negligible.

USEPA (2011a) concluded egg solids would not result in a hazard or toxic risk to nontarget organisms. The lack of toxicity and the environmental fate properties for putrescent whole egg solids and WS low use patterns indicate WS use of MRP products containing putrescent whole egg solids will not harm nontarget terrestrial and aquatic species.

8 SODIUM LAURYL SULFATE (SLS)

8.1 Problem Formulation

8.1.1 Chemical Description and Product Use

Sodium lauryl sulfate or SLS (chemical formula $C_{12}H_{25}NaO_4S$; CAS number 151-21-3; synonyms: sodium dodecyl sulfate, sulfuric acid monododecyl ester, and sodium salt) is an anionic surfactant derived from coconut or palm kernel oil that is commonly found in soaps and other products for its detergent properties (Baker and Grant 2018d, NIH 2023b, USEPA 2009c). In addition to being an MRP, SLS is also an inert ingredient in over 370 registered pesticides (USEPA 2009c) and an active ingredient in two USEPA registered, multi-active ingredient pesticides: an antiviral facial tissue and a hospital bacterial disinfectant (USEPA 2023c).

An MRP product that WS uses and distributes to cooperators, Liquid Fence, deters mammalian herbivores from browsing. The product includes SLS and other MRP active ingredients in its formulation (Table 1), which are covered separately in this assessment. SLS is also the sole active ingredient within MRP products used by WS as wetting agents to control blackbirds in upland roosts away from bodies of water (Table 1) (USDA 2021). SLS used as a wetting agent must remain heated above 21°C (70°F) before and during use to ensure proper flow throughout the spray application (USDA 2021).

8.1.2 Physical and Chemical Properties

SLS in liquid form is white to pale yellow and has a faint odor of fatty substances (NIH 2023b). SLS has a reported melting point ranging from 204 – 405°C, a boiling point of 588°C, and is moderately soluble in water (Baker and Grant 2018d, NIH 2023b). SLS has a density of 0.6 g/cm^3 at 25°C (Baker and Grant 2018d), reported vapor pressures ranging from $4.7x10^{-13}$ to $1.1x10^{-12}$ mm Hg at 25°C, and a log Kow of 1.6 (Baker and Grant 2018d, NIH 2023b).

8.1.3 Environmental Fate

SLS has a half-life in soil of 77.5 hours, a half-life in the air of 0.7 hours, and a half-life in water of 19.8 hours (Baker and Grant 2018d), indicating low to no persistence in the environment. SLS is rapidly biodegradable (Baker and Grant 2018d, NIH 2023b, OECD 1995, USEPA 2009d;2019).

8.1.4 Hazard Identification

SLS is considered to be low to moderately toxic to humans with a probable oral lethal dose between 500 – 5,000 mg/kg-bw (Baker and Grant 2018d, USEPA 2009c;2019). SLS can cause contact dermatitis in humans and erythemato-papular allergic reactions in approximately 6.4% of people incidentally exposed (Baker and Grant 2018d).

SLS is classified as GRAS when used as a food additive with limitations (21 CFR 172.822) and is exempt from the requirement of a tolerance for residues in foods (40 CFR 180.940).

Between 1996 and 2016, there were 11 human health-related incidents involving SLS in the National Pesticide Information Center (NPIC), but all involved active ingredients in addition to SLS (Baker and Grant 2018d). USEPA reviewed the Incident Data System between 1948 and 2010 and found only one adverse effects incident report for SLS, where a person experienced blisters on their face and nose, which remained for 3.5 weeks after the exposure to SLS (Baker and Grant 2018d, USEPA 2010b). In that same period, USEPA (2010b) reported 76 incidents associated with lauryl sulfates involving domestic animals, including hair loss, difficulty breathing, and rashes.

USEPA waived the data requirements for quantitative dietary (food and drinking water) exposure due to SLS's toxicity, broad availability for human consumption, and history of safe use (USEPA 2022b).

8.2 Dose-Response Assessment

8.2.1 Human Health Dose-Response

Acute Toxicity

SLS has an acute oral LD_{50} of 1,288 mg/kg-bw (Toxicity Category III) (Baker and Grant 2018d, Merck 2023, NIH 2023b, USEPA 2009c), an acute inhalation (1-hr) LC_{50} of >3,900 mg/L in rats (Toxicity Category IV), and an acute dermal LD_{50} of 600 mg/kg-bw in rabbits (Toxicity Category II) (Baker and Grant 2018d, NIH 2023b). SLS is a moderate eye and skin irritant but not a skin sensitizer (Baker and Grant 2018d, NIH 2023b).

Subchronic and Chronic Toxicity

In a 28-day subchronic oral (gavage) toxicity study in rats that were administered SLS in doses of 0, 30, 100, and 300 (which was increased to 600 after 14 days) mg/kg-bw/day, the NOAEL for SLS was 100 mg/kg-bw/day, and the LOAEL was 300/600 mg/kg-bw/day (NIH 2023b, USEPA 2009c). Observed adverse effects in the 300/600 mg/kg-bw/day group included decreased weight gain (males), increased kidney, brain, and liver weights, increased levels of alanine aminotransferase, decreased thymus weights, ulcerations and bleeding in the stomach, and reversible alterations of the tongue, myocardium, and forestomach (NIH 2023b). In a 28-day subchronic oral (dietary) toxicity study, rats were administered SLS in doses of 0, 25, 50, 110, 200, 420, 830, and 1,600 mg/kg-bw/day (USEPA 2009c). The NOAEL for SLS was 108 mg/kg-bw/day, and the LOAEL was 207 mg/kg-bw/day based on increased liver weights, hypertrophy, and elevated alanine aminotransferase levels (USEPA 2009c).

In a 90-day oral (dietary) toxicity study with SLS in rats at 0, 58, 116, 230, 460, 920, and 1,840 mg/kg-bw/day, the NOAEL was 460 mg/kg-bw/day (USEPA 2009c). The LOAEL was 920 mg/kg-bw/day based on increased liver weights, elevated liver enzymes, and histopathological changes (USEPA 2009c). In a one-year dietary toxicity study in beagles (2 males and 2 females per group), the NOAEL for SLS was 400 mg/kg-bw/day, and the LOAEL was 800 mg/kg-bw/day; the only observed adverse effect was decreased rate in body weight gain (NIH 2023b).

No subchronic or chronic toxicity studies were available for dermal or inhalation exposure routes (USEPA 2009c).

Developmental and Reproductive Toxicity, Neurotoxicity Effects, Carcinogenicity and Mutagenicity, Immunotoxicity Effects, Endocrine Effects

In a developmental oral (gavage) toxicity study with SLS in mice and rabbits, the developmental NOAEL for SLS was 300 mg/kg-bw/day, and the LOAEL was 600 mg/kg-bw/day, with total litter losses secondary to maternal effects and minor skeletal anomalies in mice (Baker and Grant 2018d, USEPA 2009c). The NOAEL for rats was 600 mg/kg-bw/day, the highest dose level tested (USEPA 2009c). The maternal LOEL was 300 mg/kg-bw/day for rats, rabbits, and mice, with reduced weight gain, and the maternal NOEL was 2 mg/kg-bw/day (USEPA 2009c).

In a reproductive toxicity study in mice, the NOAEL for reproduction was 1,000 mg/kg-bw/day, and the LOAEL could not be established (summarized by OECD (1995). The author concluded SLS did not cause adverse effects on fertility as the highest dose tested was above doses that cause significant parental toxicity.

SLS was not genotoxic in a bacterial reverse mutation test or an *in-vivo* mammalian micronucleus assay (USEPA 2009c). No carcinogenicity studies were available for SLS, but the negative results of a carcinogenicity study for a related substance suggest SLS is also not carcinogenic (USEPA 2009c).

No reproductive toxicity, neurotoxicity studies, or immunotoxicity studies were available (USEPA 2009c).

8.2.2 Ecological Effects Dose Response

Aquatic Effects Analysis

SLS is moderately toxic to fish and moderately to highly toxic to aquatic invertebrates (Table 5).

An estimated bioconcentration factor (BCF) of 71 suggests a moderate potential for bioconcentration in aquatic organisms (NIH 2023b).

USEPA (2009d) reported a 48-hr EC_{50} for marine aquatic plants (algae, *Champia parvula*) as 0.3 mg/L.

Terrestrial Effects Analysis

There is relatively little ecotoxicity data available for terrestrial animals or plants. SLS has low toxicity to terrestrial mammals based on the acute oral LD_{50} of 1,288 mg/kg-bw in rats (USEPA

2009c). USEPA (2009d) did not require avian ecotoxicity data or additional mammalian ecotoxicity data during registration review of the registered SLS products.

There are no ecotoxicity data available for terrestrial invertebrates. However, Baker and Grant (2018d) reported studies on the efficacy of SLS through mechanical means (lowering the surface tension of the water) or synergistic effects with other active ingredients when MRP products are used as insecticides against various invertebrate pest species.

SLS may have some phytotoxicity to terrestrial plants (Baker and Grant 2018d). OECD (1995) reported a 48-hr EC_{50} of 361 mg/L for the chickpea (*Cicer arietinum*) and 384 mg/L for the white lupin (*Lupinus albus*).

8.3 Exposure Assessment and Risk Characterization

8.3.1 Human Health Exposure and Risk Characterization

Occupational exposure to SLS may occur through inhalation and dermal routes of exposure. The general public is consistently exposed to SLS via ingestion and dermal contact with numerous categories of food and cosmetic consumer products containing SLS (NIH 2023b). Due to the low toxicity of SLS to humans or mammals, the low volumes used by WS, and the training of WS applicators in properly using PPE and pesticides, the risks to WS applicators or the public from WS's use of SLS are negligible.

8.3.2 Ecological Exposure and Risk Characterization

SLS is readily biodegradable and is found at very low concentrations in the deer and rabbit MRP repellent product (0.040% w/w) used by WS, which WS also uses at low volumes. Based on their low toxicity, MRP products containing SLS pose little to no risk to nontarget terrestrial mammalian species. Because WS applicators apply SLS wetting agents directly to the target bird species, the risks of applying SLS to nontarget bird species are minimal.

Aquatic fish and invertebrate species are sensitive to or at risk from SLS. However, WS's use of MRP products containing SLS at blackbird roost sites away from where runoff is likely to enter water resources (USDA 2021) reduces risks to nontarget aquatic species. Any low risks to nontarget terrestrial plant species will be localized to where the birds are roosting.

Table 5. Acute and chronic toxicity to aquatic vertebrates and invertebrates for SLS.

Taxonomic group	Test species	Test	Result	Reference
Freshwater Fish	Rainbow Trout (*Oncorhynchus mykiss*)	24-hr LC_{50}	58.1 mg/L	(Baker and Grant 2018d)
Freshwater Fish	Rainbow Trout (*Oncorhynchus mykiss*)	48-hr LC_{50}	41.2 mg/L	(Baker and Grant 2018d)
Freshwater Fish	Rainbow Trout (*Oncorhynchus mykiss*)	96-hr LC_{50}	24.9 mg/L	(Baker and Grant 2018d)
Freshwater Fish	Sheepshead Minnow (*Cyprinodon variegatus*)	96-hr LC_{50}	1.7 mg/L	(NIH 2023b)
Freshwater Fish	Striped Dwarf Catfish (*Macrones vittatus*)	96-hr LC_{50}	1.39 mg/L	(OECD 1995)
Marine Fish	Inland Silverside (*Menidia beryllina*)	7-day LC_{50} (larvae)	1.8 mg/L	(USEPA 2009d)
Freshwater Invertebrates	Rotifer (*Brachionus rubens*)	48-hr EC_{50}	1.8 mg/L	(USEPA 2009d)
Freshwater Invertebrates	Rotifer (*Brachionus rubens*)	24-hr EC_{50}	1.35 mg/L	(OECD 1995)
Freshwater Invertebrates	Water Flea (*Daphnia magna*)	48-hr EC_{50}	1.8 mg/L	(OECD 1995)
Freshwater Invertebrates	Water Flea (*Daphnia magna*)	40-day NOEC	2 mg/L	(USEPA 2009d)
Marine and Estuarine Invertebrates	Mysid (*Americamysis bahia*)	96-hr LC_{50}	4.2 mg/L	(NIH 2023b)
Marine and Estuarine Invertebrates	Mysid (*Metamysidopsis swifti*)	96-hr LC_{50}	3.2 mg/L	(NIH 2023b)
Marine and Estuarine Invertebrates	Eastern Oyster (*Crassostrea virginica*)	48-hr EC_{50}	1.7 mg/L	(NIH 2023b)
Marine and Estuarine Invertebrates	Pacific Oyster (*Crassostrea gigas*)	48-hr EC_{50}	0.84 mg/L	(OECD 1995)
Marine and Estuarine Invertebrates	American Lobster (*Homarus americanus*)	96-hr EC_{50}	0.72 mg/L	(OECD 1995)

9 THYME OIL

9.1 Problem Formulation

9.1.1 Chemical Description and Product Use

Thyme oil (CAS number 8007-46-3; synonym oil of thyme) is a naturally occurring oil extract from the flowering tops of thyme plants (*Thymus vulgaris* and *T. zygis*). Thyme oil is used in cosmetics, aromatherapy treatments, topical treatments, and toothpaste (Baker and Grant 2018e). Thyme oil consists of 3 – 80% thymol, a volatile phenol (CAS number 89-83-8) (Baker and Grant 2018e, NIH 2023c). Thymol is thought to be the main active component in thyme oil (Baker and Grant 2018e). Thyme oil has demonstrated insecticidal properties as well as anti-microbial and anti-fungal properties (Baker and Grant 2018e). Thyme oil is also a non-food-use-only inert ingredient in registered pesticides (USEPA 2023d)

The MRP product containing thyme oil that WS uses or distributes has other MRP active ingredients in its formulation, which are covered separately in this assessment. WS may use and distribute MRP products containing thyme oil to cooperators to deter herbivores from browsing. In addition to being an MRP, thyme oil (under the active ingredient name oil of thyme) is the sole active ingredient in several botanical (flower oil) products registered with USEPA that target fungal and bacterial pathogens on crops and ornamental plants and is an active ingredient in one registered, multi-active ingredient botanical insecticide (USEPA 2023b).

9.1.2 Physical and Chemical Properties

Thyme oil is a colorless to reddish-brown liquid (Baker and Grant 2018e). Thyme oil has the odor of thyme and is very slightly soluble in water (Baker and Grant 2018e, Merck 2023). Thyme oil has a melting point of 250°C and a boiling point of 190°C (Baker and Grant 2018e). Thyme oil has a density of 0.916 g/cm^3, a vapor pressure of 0.167 mm Hg at 25°C, and a log K_{ow} ranging from -1.77 to -1.69 (Baker and Grant 2018e).

9.1.3 Environmental Fate

Thyme oil has a half-life in soil of 720 hours, a half-life in air of 2.4 hours, and a half-life in water of 360 hours (Baker and Grant 2018e), indicating low to moderate persistence in the environment. Thyme oil rapidly biodegrades in the environment (USEPA 2020).

9.1.4 Hazard Identification

Thyme oil from *T. vulgaris* and the *T. zygis* var. *gracilis* is considered GRAS when used as a food additive (21 CFR 182.20).

USEPA (2020) reviewed the Incident Data System and identified 2 reported human incidents associated with thyme oil with moderate adverse effects, including an allergic reaction. The remaining three incidents report adverse effects on domestic animals ranging from minor to one fatality. No information was reported for the domestic animal fatality.

9.2 Dose-Response Assessment

9.2.1 Human Health Dose-Response

Acute and Subchronic Toxicity

The acute oral LD_{50} values for thyme oil are 2,840 mg/kg-bw in rats (Toxicity Category III), 1,250 mg/kg-bw in mice (Toxicity Category III), and >5,000 mg/kg-bw in rabbits (Toxicity Category IV) (Baker and Grant 2018e, USEPA 2020). In rabbits, the acute dermal LD_{50} for thymol is >5,000 mg/kg-bw, indicating that thyme oil is also nontoxic for dermal exposure (Baker and Grant 2018e). Oil of thyme is considered a sensitizer (USEPA 2020).

In a subchronic (28-day) oral (gavage) toxicity study in rats, the NOAEL was determined to be 100 mg/kg-bw/day (Rojas-Armas et al. 2019).

Chronic, Developmental, and Reproductive Toxicity, Neurotoxicity Effects, Carcinogenicity and Mutagenicity, Immunotoxicity Effects, Endocrine Effects

Thyme oil is not considered to be genotoxic, based on a lack of mutagenicity in an Ames assay and a negative result for genotoxicity in a chromosomal aberration assay in Chinese hamster fibroblasts (Cohen et al. 2021).

No neurotoxicity, immunotoxicity, chronic, developmental, or reproductive toxicity data were available for human health effects of thyme oil. These data were again waived by USEPA during the registration review (USEPA 2020).

9.2.2 Ecological Effects Dose Response

Aquatic Effects Analysis

Thyme oil is slightly toxic to aquatic invertebrates with a 48-hr EC_{50} (immobilized) of 11.787 mg/L in the water flea (*Daphnia magna*) (Arslan et al. 2014). This toxicity is likely due to the thymol component within thyme oil, which is moderately toxic to aquatic invertebrates (48-hr LC_{50} for thymol is 4.9 mg/L for *Daphnia magna*) (Baker and Grant 2018e).

Thyme oil is nontoxic to freshwater fish with a 24-hr, 48-hr, and 72-hr LD_{50} of 21,100 mg/L and a 96-hr LD_{50} of 20,500 mg/L for juvenile coho salmon (*Oncorhynchus kisutch*) and a 24-hr, 48-hr, 72-hr, and 96-hr LD_{50} of 16,100 mg/L for rainbow trout (*O. mykiss*) (Stroh et al. 1998).

USEPA waived all nontarget organism and environmental fate data requirements for thyme oil during the registration review (USEPA 2020). USEPA (2020) reviewed the Incident Data System, and no reported ecological incidents were associated with thyme oil.

Terrestrial Effects Analysis

The acute oral LD_{50} values for thyme oil are 2,840 mg/kg-bw in rats, 1,250 mg/kg-bw in mice, and >5,000 mg/kg-bw in rabbits (Baker and Grant 2018e, USEPA 2020). No other data is available on the ecotoxicity of thyme oil to nontarget terrestrial mammals or birds, but toxicity is likely low to minimal (USEPA 2020).

Thyme oil is slightly to moderately toxic to the obliquebanded leafroller (*Choristoneura rosaceana*) larvae on an acute contact basis (LD_{50} of 11.2 µg/insect) (Machial et al. 2010). Thyme oil appears to be moderately toxic to honey bees on an acute oral basis, with mortalities occurring at 8 µg/bee following 24-hr and 48-hr exposures (Albo et al. 2003). However, acute oral LD_{50} values could not be estimated due to negative curves for mortality with potential delayed consumption and volatility of thyme oil, potentially impacting the results at the higher dose levels (Albo et al. 2003).

9.3 Exposure Assessment and Risk Characterization

9.3.1 Human Health Exposure and Risk Characterization

Thyme oil has minimal toxicity or other human health hazards and is commonly found in consumer cosmetics and other products (USEPA 2020). Due to the low toxicity of thyme oil to humans or mammals, the low volumes used by WS, and the training of WS applicators in the proper use of PPE and pesticides, the risks to WS applicators or the public from WS's use or distribution of the MRP repellent product containing thyme oil are negligible.

9.3.2 Ecological Exposure and Risk Characterization

USEPA (2020) concluded thyme oil contained in registered pesticides would not result in a hazard or toxic risk to nontarget organisms. The lack of toxicity and the environmental fate properties for thyme oil and WS use patterns for the MRP product containing thyme oil will also not pose a risk to nontarget terrestrial and aquatic species. Although one product containing thyme oil is registered with USEPA as a botanical insecticide, USEPA (2020) determined that risk to pollinators is not expected due to the use of thyme oils. No risk to terrestrial invertebrates, including honey bees, is expected to result from the low concentration of thyme oil (0.010% w/w) in the MRP repellent product used and distributed by WS.

10 UNCERTAINTIES AND CUMULATIVE IMPACTS

The uncertainties associated with this risk assessment arise primarily from a lack of information about the effects of MRPs, their formulations, metabolites, and potential mixtures on nontarget organisms that can occur in the environment. These uncertainties are not unique to this assessment but are consistent with uncertainties in human health and ecological risk assessments with any environmental stressor.

Another uncertainty in this risk assessment is the potential for cumulative impacts on human health and the environment from the proposed use of MRPs. The potential for cumulative impacts is expected to be minimal based on the low volume and minor use of MRPs in the various WS uses. Areas where cumulative impacts may occur include 1) repeated worker and environmental exposures to chemical repellents from program activities and other sources, 2) exposure to other chemicals with a similar mode of action, and 3) exposure to other chemicals affecting the toxicity of MRPs.

From a human health perspective, cumulative impacts on human health are expected to be negligible because of these MRPs' favorable toxicity profiles and minimal exposure to workers and the public. The lack of exposure and risk to the public suggests that cumulative impacts would also be incrementally negligible when factoring in other stressors.

Cumulative impacts on ecological resources are also expected to be incrementally negligible. When utilized according to label mandates, risks of the reviewed MRPs to aquatic resources and most terrestrial nontarget wildlife are low due to low toxicity and/or mitigated exposure pathways. There is higher uncertainty on the potential cumulative impacts on aquatic species for any future use of sodium lauryl sulfate by WS compared to the other MRPs that WS may use or distribute. However, WS applies SLS to blackbird roost sites away from where runoff is likely to enter water resources (USDA 2021), which reduces exposure and risks to nontarget aquatic species.

11 SUMMARY

WS uses MRPs to manage several bird and mammal species that damage a variety of agricultural and non-agricultural resources. MRPs pose a negligible risk of primary or secondary poisoning to nontarget animals, including scavengers. WS use patterns and environmental fate properties indicate MRP products used by WS pose no risk to aquatic nontarget wildlife. The WS use pattern and application rates of MRPs mostly on private lands, resulting in a negligible risk for the public. The dietary risk from MRP exposure to the public is low since most of the repellents are considered nontoxic to people, are allowed for food uses, do not threaten drinking water, and many are not used by WS on edible plant parts. The risk to WS applicators is also low because they receive training in using PPE and pesticides. The release of MRPs into the environment is expected to have no or negligible impacts on nontarget species, the public, and the environment, including cumulative impacts.

Although SLS may pose higher risks to aquatic species, aquatic exposure from proposed SLS MRP applications is expected to be negligible based on the application method, use-sites away from where runoff may expose aquatic species and environmental fate properties of SLS. All MRP applications are made by hand or with ground-based equipment. The MRPs that WS proposes to use or distribute have minimal to no toxicity to nontarget terrestrial species and are all readily biodegradable.

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Experience: Special expertise in wildlife biology, identification, ecology, and damage management. Thirty-eight 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. Researched, applied and supervised the use of repellents.

Editors/Contributors for "Use of Minimum Risk Pesticides Used in Wildlife Damage Management Risk Assessment":

Editor: Anthony D'Alessio
Position: USDA-APHIS-Policy and Program Development (PPD), Environmental and Risk Analysis Services (ERAS), Biological Scientist, Raleigh, NC

Education: Three years of undergraduate education in Agricultural and Resource Economics with a concentration in policy from the University of Maryland, College Park.

Experience: Three years of relevant undergraduate coursework and internship experience with the APHIS preparing analyses in compliance with the Endangered Species Act and National Environmental Policy Act.

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: Thirteen 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: Michael McCaskill

Position: USDA-APHIS-Policy and Program Development (PPD), Environmental and Risk Analysis Services (ERAS), Toxicologist, New Market, MD

Education: B.S. Environmental Science – University of Florida; MPH Industrial Hygiene-University of South Carolina, Ph.D. Toxicology-Florida Agriculture and Mechanical University

Experience: Ten years of experience conducting human toxicological research at Florida Agriculture and Mechanical University, University of Nebraska Medical Center, and Tulane University. Four years of experience conducting human health and environmental toxicological risk assessments and assisting environmental compliance programs at the Florida Department of Health, Commonwealth of Pennsylvania, and USDA.

Data Contributor: Joey Millison

Position: USDA-APHIS-WS Information and Technology (IT), Junior Applications Developer

Education: Information and Technology coursework from various sources

Experience: Eleven years of experience in APHIS, WS Management Information System (MIS) Group. Retrieves WS field data from the MIS for writers, reviewers, and editors.

13.2 Internal Reviewers

USDA APHIS Wildlife Services

Reviewer: Jimmy Taylor

Position: USDA-APHIS-WS, NWRC, Assistant Director, Fort Collins, CO

Education: BS Forest Management (Wildlife Option) – Mississippi State University; MS Wildlife Ecology – Mississippi State University; PhD Forest Resources (emphasis in wildlife) – Mississippi State University

Experience: Twenty one years of service in APHIS conducting and supervising wildlife damage management research.

Reviewer: Nokota Harpster
Position: USDA-APHIS-WS Staff Wildlife Biologist for Pennsylvania WS
Education: Bachelor of Science-Wildlife Conservation from Juniata College.
Experience: 8 years working for WS.

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.

13.3 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 "Minimum Risk Pesticides" peer reviewed. WS worked with the Association of Fish and Wildlife Agencies to have experts review the documents.

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

South Dakota Game, Fish, and Parks

Louisiana Department of Wildlife and Fisheries

Arizona Game and Fish Department, Association of Fish and Wildlife Agencies

13.3.2 Comments

1. While the uncertainties are well described, there are two agents for which the lack of available information may be significant. Specific agent concerns:

a. Corn oil: Ecological effects – there is no data other than the occlusive effects on insect spicules. Also, the environmental fate indicates persistence in soil and water. It is listed as biodegradable, however no values or process are provided. Because of this, I believe the Ecological Risk Characterization should be considered unknown but likely low risk because of the lack of oral toxicity and low-use volumes.

RESPONSE: We have included a reference in Section 3.1.3 on the amount of time for biodegradation of vegetable oils. The half-life values provided are estimates based on the USEPA Estimation Program Interface, a downloadable program that provides users with estimates of physical/chemical and environmental fate properties when suitable data from the literature are not available. We disagree that these estimations indicate persistence in soil and water. We have reported that WS use of corn oil poses little to no exposure risk to nontarget terrestrial or aquatic species. Although there are some unknown factors related to corn oil, it is a common food ingredient. We disagree that the risk characterization should be described as unknown.

b. SLS: Because EPA didn't require avian ecotoxicity data and because the product is moderately toxic to fish and moderately to highly toxic to aquatic invertebrates, there should be concern with the use of this product in some locations. I agree that it isn't likely to be a concern in deer and rabbit MRP products, given the low concentration in those formulations. I recognize that most roost sites are not near water sources or where runoff might be an issue. While the purpose of this review is to comment on ecotoxicology and human health risks, I believe there are animal welfare issues with its use. While surfactant spraying is listed in the AVMA guidelines on depopulation (AVMA 2019 ISBN 978-1-882691-53-1), it is based on a 1979 reference with few details on the product use, indications that the method is difficult to implement, and little indication that the process was effective. The AVMA guidelines on euthanasia do not include hypothermia as an acceptable or conditional method of euthanasia.

RESPONSE: WS use of SLS as a wetting agent is limited to upland roost sites away from water sources per the USDA tech note for use of SLS as a European starling and blackbird wetting agent (USDA 2021). WS careful selection of sites appropriate for application of SLS as a wetting agent reduces the concern with the use of the product due to location. The AVMA guidelines for depopulation cite a single reference, (Weatherhead et al. 1979. On the feasibility of surfactants as a blackbird management tool in Quebec, Proceedings of the Bird Control Seminar 7: 291-301), that is based on a different wetting agent (PA-14) and the application of surfactants with helicopters. Controlled experiments have been conducted with SLS showing that blackbird death occurred within 60 minutes (Byrd et al. 2009, Evaluation of sodium lauryl sulfate as a blackbird wetting agent, Proceedings of the Wildlife Damage Management Conference 13: 191-196). And the technique used by WS employees for the application of SLS does not rely on meterological conditions (rain events). Instead, it uses a spray system to ensure the appropriate conditions are present. The use of surfactants for control of roosting blackbirds is not euthanasia, and the AVMA guidelines on euthanasia do not apply here.

Comments received not requiring a response.

1. We would advocate the continued use of the products used to continue to provide effective management and tools for the targeted species.
2. I find the document to be concise, thorough, and contain pertinent information to the evaluation of the products. The consequences for the use of each product were well defined.
3. Mitigating actions are clearly outlined and are thorough in detail. All uncertainties and assumptions were clearly illuminated in the document.
4. I feel that safety factors for humans and the environment were thoroughly vetted. References were numerous and well sourced and indicative of a complete investigation of the products.
5. Overall, this assessment is complete and the areas regarding mitigation and standard operating procedures have incorporated the available science. The section detailing the uncertainties and cumulative impacts is complete as well.

APPENDIX TABLE A.1. The annual average number of gallons or pounds of minimum risk pesticides (MRPs) applied by APHIS-WS in WDM in FY11 – FY15 for all products with the number of work tasks (WTs) associated with the applications.

MRP Active Ingredient(s) (% w/w, CAS Number)	Product	Applied (gal/lb)	WTs	States Used	Distributed (gal/lb)	WTs	States Used
Putrescent Whole Egg Solids (1.12%; 51609-52-0) Cloves (0.54%; N/A) Garlic Oil (0.03%; 8000-78-0)	Shot-Gun® Repels-All® (granules, Bonide® Products LLC)	-	-	-	0.6 lb	0.2	NH
Putrescent Whole Egg Solids (1.040%; 51609-52-0) Garlic (0.374%; N/A) Sodium Lauryl Sulfate (0.040%; 151-21-3) Potassium Sorbate (0.495%; 24634-61-5) Thyme Oil (0.010%; 8007-46-3)	Liquid Fence® Deer & Rabbit Repellent (liquid, The Liquid Fence Co., now Spectrum Brands, Inc.)	-	-	-	7.8 gal	7.7	NH
Dried Blood (12.0%; 68911-49-9)	Plantskydd® Repellent (liquid, Tree World® Plant Care Products Inc.)	-	-	-	0.7 gal	2.4	NH
Dried Blood (100%; 68911-49-9)	Plantskydd® Repellent (powder concentrate, Tree World® Plant Care Products Inc.)	-	-	-	11.4 lb	6.6	NH
Dried Blood (100%; 68911-49-9)	DeerOff® Deer Repellent (liquid)	-	-	-	3.7 gal	3.4	NH
Sodium Lauryl Sulfate (28–30%; 151-21-3)	Multiple	1 gal.	0.2	IL	-	-	-
Corn Oil (100%; 8001-30-7)	Multiple	38.5 gal.	515	27*	-	-	-

*AR, CA, CO, GA, ID, IL, IN, KS, KY, MD, MI, MN, MO, NC, NE, NV, NY, OR, PA, TN, TX, VA, VT, WA, WI, & WV plus DC