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Rangeland Grasshopper and Mormon Cricket Suppression Program

Final Environmental Impact Statement

November 2019

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Executive Summary

The U.S. Department of Agriculture, Animal and Plant Health Service (USDA-APHIS) has prepared an updated environmental impact statement (EIS) for the grasshopper and Mormon cricket suppression program in 17 Western States. Grasshoppers and Mormon crickets are a natural component of rangeland in the western United States; however, under appropriate environmental conditions their numbers can reach levels that result in economic and environmental impacts to rangeland and adjacent agriculture crops. USDA-APHIS works cooperatively with Federal and State agencies to survey for grasshoppers and Mormon crickets, and under certain conditions will make an insecticide application to suppress populations.

This EIS considers potential environmental impacts from each of the alternatives proposed for the Grasshopper and Mormon Cricket Suppression Program. USDA-APHIS can tier subsequent site-specific environmental assessments (EAs) to this EIS, incorporating, by reference, analyses included in this document. This EIS will provide the interested public with a programmatic analysis of the potential for environmental impacts from the alternatives available to USDA-APHIS.

On September 1, 2016, USDA-APHIS published a notice of intent (NOI) in the *Federal Register* (FR) describing its intent to prepare a programmatic EIS for the USDA-APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program (Docket No. APHIS-2016-0045). The NOI invited the public to submit comments to further define the scope of the alternatives and express their interests in the Program. USDA-APHIS received 12 comment letters during the 45-day scoping period and considered the comments in the planning of this EIS. On January 30, 2019 USDA APHIS published the draft EIS for the USDA-APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program. USDA-APHIS received 15 comments regarding the draft EIS during the 45-day public comment period.

This EIS updates the 2002 EIS with new tools and available data. The EIS evaluates the three alternatives listed below:

1. No action. Under this alternative, USDA-APHIS would maintain the Program that was described in the 2002 EIS and Record of Decision. This alternative represents the baseline against which a proposed action may be compared.

2. No suppression program. Under this alternative, USDA-APHIS would not fund or participate in any program to suppress grasshopper outbreaks. USDA-APHIS may opt to provide technical assistance, but any suppression program would be implemented by a Federal land management agency, a State agriculture department, a local government, or a private group or individual.

3. Adaptive management (preferred alternative)**.** Under this alternative, USDA-APHIS would update new information and technologies that were analyzed in the 2002 EIS. The insecticides available for USDA-APHIS use include carbaryl, diflubenzuron, chlorantraniliprole, and malathion. USDA-APHIS would apply one insecticide to a treatment area at the USDA-APHIS rate (which is less than the label rate), or the more commonly used reduced agent area treatment (RAAT) rate for grasshopper suppression . Under this alternative, the RAATs strategy uses a reduced rate by alternating treatment swaths in a spray block, reducing application rates, or both. Adaptive management enables the Program to add other treatment(s) that may become available in the future for managing grasshoppers if it poses no greater risks to human health and non-target organisms than the risks associated with approved treatments. An adaptive approach of USDA-APHIS rates or RAATs will allow the Program to make site-specific suppression applications using a range of application rates to ensure adequate suppression.

Impacts under the no suppression alternative could result in increased grasshopper and Mormon cricket populations. In addition, the no suppression alternative may result in the use of higher insecticide application rates and higher-risk insecticides than those proposed under alternatives one and three. Impacts from the use of Program insecticides are reduced based on the lower use rates and other Program-specific measures designed to reduce risk to the human environment.

No site-specific eradication projects will be implemented as a direct result of the decision that will follow this EIS. If the Program decides to implement a treatment project USDA-APHIS will prepare a site-specific EA.

Selection of the preferred alternative allows the Program to implement proven measures to control grasshopper and Mormon cricket populations that reach economically damaging levels in rangeland. The preferred alternative also allows the greatest flexibility to the Program when addressing site-specific issues related to making a suppression treatment while protecting the human environment.

I. Purpose of and Need for Action

Rangelands provide many goods and services, including economic services such as food, fiber, and grazing land for cattle (Havstad et al., 2007; Follett and Reed, 2010). Ecological services provided include carbon sequestration, provision of water, air quality, and wildlife habitat and biodiversity (Havstad et al., 2007; Follett and Reed, 2010). Rangelands also provide cultural services, including recreation, open space, and vistas (Havstad et al., 2007). Grasshoppers and Mormon crickets are part of rangeland ecosystems, serving as food for wildlife and playing an important role in nutrient cycling (Belovsky et al., 1996). However, grasshoppers and Mormon crickets have the potential to occur at population levels, particularly during high levels referred to as outbreaks (Belovsky et al., 1996), that result in competition with livestock and other herbivores for rangeland forage and can result in damage to rangeland plant species (Wakeland and Shull, 1936; Swain, 1944; Wakeland and Parker, 1952; Hewitt, 1977; Hewitt and Onsager, 1983; Belovsky et al., 1996; Belovsky, 2000; Pfadt, 2002; Branson et al., 2006; Bradshaw et al., 2018). (The term "grasshopper" used in this environmental impact statement (EIS) refers to both grasshoppers and Mormon crickets, unless differentiation is necessary.)

a. Why is there a need to manage this pest?

Outbreaks produce high densities of grasshoppers and competition for the available food supply, which may cause damage to rangeland and nearby crops (Wakeland and Shull, 1936; Swain, 1944; Wakeland and Parker, 1952; Pfadt, 2002; Branson et al., 2006). Large numbers of grasshoppers can compete for food with livestock and other grazing plant-eating species by reducing available forage (Branson et al., 2006). The purpose of the proposed action is to protect rangelands and nearby crops of the western United States from the adverse effects of grasshopper outbreaks. Despite the best land management efforts to prevent outbreaks, grasshopper populations may build to levels of economic infestation[1] where direct intervention may be the most viable option to suppress them.

[1] The "level of economic infestation" is a measurement of the economic losses caused by a particular population level of grasshoppers to the infested rangeland. This value is determined on a case-by-case basis with knowledge of many factors including, but not limited to, the following: economic use of available forage or crops; grasshopper species, age, and density present; rangeland productivity and composition; accessibility and cost of alternative forage; and weather patterns. In decision-making, the level of economic infestation is balanced against the cost of treating to determine an "economic threshold" below which there would not be an overall economic benefit for the treatment. Short-term economic benefits accrue during the years of treatments, but additional long-term benefit may accrue and be considered in deciding the total value gained by a treatment. Additional losses to rangeland habitat and cultural and personal values (e.g., aesthetics and cultural resources), although they may also be a part of decision-making, are not part of the economic values in determining the necessity for treatment (USDA APHIS, 2002).

However, not all grasshopper species are damaging, and action to protect rangeland resources is not always required when grasshopper populations increase. There are more than 400 species of grasshoppers in western North America, but only about a dozen grasshopper species frequently develop high densities on rangelands (Skinner, 2000).

When a rapid and effective response to a developing grasshopper outbreak is required, a Federal agency or a State agriculture department (on behalf of a State, a tribe, a local government, or a private group or individual) may request assistance from the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) to suppress rangeland grasshopper populations in 17 Western States. These States include: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

The objectives of the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program (Program) are to 1) conduct surveys of grasshopper populations in 17 Western States; 2) provide technical assistance to land managers; and 3) when requests are made and funds permit, suppress economically damaging grasshopper and Mormon cricket outbreaks on Federal, Tribal, State, and private rangeland. APHIS uses several factors to determine if grasshopper suppression is warranted, including, but not limited to, the pest species present, maturity of the pest species population, timing of treatment, cost benefits of conducting the action, and ecological considerations (see footnote on prior page) (USDA APHIS, 2008).

b. Who has authority to act?

The USDA became involved in grasshopper control on Federal rangeland in the 1930s. During that decade, grasshopper infestations covered millions of acres in 17 Western States. Unsuccessful efforts to control grasshopper outbreaks on a local basis proved that grasshoppers needed to be dealt with on a broader basis. In 1934, Congress charged USDA with controlling grasshopper infestations on Federal rangeland. Thereafter, USDA was the lead agency in cooperative efforts among Federal agencies, State agriculture agencies, and private ranchers to control grasshopper outbreaks. USDA's legal authorities to cooperate in those outbreaks came from the Incipient and Emergency Control of Pests Act (1937), the Organic Act of the Department of Agriculture (1944), the Cooperation with State Agencies in the Administration and Enforcement of Certain Laws Act (1962), and the Food Security Act (1985).

Today, APHIS has a broad mission that includes protecting and promoting U.S. agricultural health, and protecting and promoting food, agriculture, natural resources, and related issues. Specifically, the Plant Protection Act of 2000 (PPA) (7 United States Code (U.S.C.) 7701 *et seq*.) provides the authority for APHIS to take actions to exclude, eradicate, and control plant pests, including grasshoppers. According to the authority delegated under section 417 of the PPA (7 U.S.C. § 7717), APHIS may be requested to work in conjunction with a Federal land management agency or a State agriculture department (on behalf of a State, local government, tribe, private group, or individual) to treat areas that are infested with grasshoppers when they reach a level of economic infestation. In satisfying this mandate, APHIS uses a Federal cost share program to carry out actions using insecticides to reduce grasshopper populations, subject to available funds.

APHIS does not have the authority to conduct suppression programs for grasshoppers on private croplands. However, if small amounts of croplands (typically less than 15 percent of the treatment area) are interspersed in a rangeland treatment block, APHIS could treat the entire block in order to maintain the continuity of the treatment area. The insecticide, however, must be labeled for use on that crop. In such cases, APHIS would charge the private crop grower 100 percent of the treatment cost for the treated crops. APHIS does conduct rangeland treatments in areas where federally administered rangeland is adjacent to crops. This not only protects the rangeland forage but also prevents grasshoppers from moving into the adjacent crops. In these situations, APHIS does not treat the crops, and the crop owner is responsible for any treatments they may need.

APHIS has a Memorandum of Understanding (MOU) with each of the three Federal agencies that represent the Program’s primary federal land management partners: U.S. Department of Interior’s Bureau of Indian Affairs (BIA) and Bureau of Land Management (BLM), and USDA’s Forest Service (FS). These MOUs concern management of grasshoppers on lands subject to the jurisdiction of each Agency, and outline the processes as to how APHIS will work with each Agency to suppress grasshoppers on the lands they manage.

c. Why do this environmental impact statement?

As a Federal Government agency subject to compliance with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321–4347), APHIS prepared this EIS in accordance with the applicable implementing and administrative regulations (40 Code of Federal Regulations (CFR) §§ 1500–1508; 7 CFR §§1b, 2.22(a)(8), 2.80(a)(30), 372). This programmatic EIS presents Program alternatives APHIS could adopt as part of the Program, and examines the potential consequences of implementing them.

This EIS is an update to the 1987 and 2002 EISs that were prepared to assess the impacts of the Program, and discloses the different methods and alternatives that APHIS could use to reduce grasshopper populations in rangelands in the western

United States. This EIS can be used as a basis for tiering site-specific environmental assessments (EA) when APHIS is requested to suppress grasshopper outbreaks. Federal land management agencies can use this information when preparing their environmental documents. They can adopt, combine, incorporate by reference, or tier their activities to the data in this EIS. This EIS will provide the interested public with a programmatic analysis of the potential for environmental impacts from the alternatives available to APHIS to suppress grasshoppers. Also, APHIS is proposing to add an additional insecticide to the Program, chlorantraniliprole, that was not included in previous EISs, and this EIS will provide a programmatic analysis of the potential environmental impacts of this insecticide. Finally, the EIS analyzes an adaptive management alternative that was not included in previous EISs. This adaptive management approach would allow the Program to make site-specific suppression applications using a range of application rates to ensure adequate grasshopper suppression.

d. Background

1. *Description and Biology of Grasshoppers and Mormon Crickets*

Grasshoppers and Mormon crickets are closely related insects — both belong to the insect order Orthoptera. Grasshoppers (Acrididae) occur throughout the North American continent and around the world while Mormon crickets (Tettigoniidae: *Anabrus simplex*) are found mostly in the Great Basin and other areas of the western United States, and are actually a flightless species of katydid. Because their feeding habits and damage are similar to that of grasshoppers, APHIS includes Mormon crickets in its suppression program (Pfadt, 2002).

Grasshoppers are relatively large insects with distinct appearances and nearly 400 species of grasshoppers are known to inhabit the 17 Western States (Pfadt, 2002). Although as many as 15 to 45 grasshopper species may be found in an area, only about a dozen species cause economic damage to rangeland, grasses, and surrounding crops (Appendix A). It is very important to note that each species alone may not cause much damage, but, when combined, can cause extensive damage.

Grasshopper species vary in densities and dominance depending on the soil, vegetation, topography, and use of a habitat. They generally are grouped into grass feeders, forb (herbaceous flowering plants) feeders, or mixed feeders (Pfadt, 2002). Grasshoppers show a great deal of species-specific variation in food plant use, ranging from specialist to generalist, although all species of grasshopper are at least somewhat selective in what they choose to eat (Chapman, 1990). A variety of factors affect food plant choice including: competition among grasshopper species, presence of plant allelochemicals (chemicals released by a plant that can have beneficial or harmful effects on another plant), grasshopper life history characteristics, mobility and dispersal abilities of different grasshopper species, nutrient properties of potential food plants, relative abundance of potential host plants, and physiological attributes specific to individual grasshopper species (Joern, 1979; Chapman, 1990).

Grasshoppers select their food by lowering their antennae to the leaf surface and tapping it with their mouthparts, tasting a potential food plant, and detecting attractant and repellent properties of plant chemicals (Pfadt, 2002). A grasshopper may take an additional taste by biting into the leaf before it begins to feed freely (Pfadt, 2002). Grasshoppers prefer young green leaves to old, yellowing ones. Ground-dwelling grasshoppers often feed in short bouts on old plant litter as well as on dry animal dung (Pfadt, 2002). Grasshopper food sources and preferences may change during outbreaks. Mormon crickets feed on a broad range of plants, but prefer certain forbs, including milk vetches, penstemon, arrowleaf balsamroot, dandelion, mustards, and pepperweed (Pfadt, 2002). They also prefer cultivated plants such as wheat, barley, alfalfa, sweetclover, and vegetable crops (Pfadt, 2002). When grasses and forbs begin seed development, adult Mormon crickets climb the plants and feed on the seed kernels (Pfadt, 2002).

Most grasshoppers are highly mobile with jumping hind legs and strong wings. They have short, relatively thick antennae, which are rarely longer than half of the body. Grasshoppers range in length from less than 1 inch to 3 inches. Most grasshopper species have long, functional wings that are used for dispersal from deteriorating habitat, migration, and to avoid predators (Pfadt, 2002).

Several species of North American grasshoppers are capable of dispersing greater distances: *Camnula pellucida*, *Dissosteira longipennis*, *Melanoplus sanguinipes*, *M. devastator*, *M. rugglesi*, *Oedaleonotus enigma*, and *Trimerotropis pallidipennis* (Pfadt, 2002). Older nymphs of the very motile grasshopper *M. sanguinipes* may swarm up to 10 miles a day (although the distance is usually less than 5 miles), and adults are known to travel 30 miles in a day or further (Pfadt, 2002). The Mormon cricket is flightless but highly mobile (Pfadt, 2002). Mormon crickets have long, thin antennae, usually longer than the body. Adults range in length from about 1 to 2.5 inches. From the time it is half grown, the cricket is capable of migrating great distances in a single day. Older instars and adults swarm in bands and may cover from 1 to 1.5 miles a day, and 25 to 50 miles in a single season (Pfadt, 2002).

2. *Life Cycle*

The grasshopper life cycle includes three stages of development: the egg, the nymph, and the adult. Each species possesses a unique set of ecological and physiological adaptations that allow it to grow, survive, and reproduce in its environment (Pfadt, 2002). The habitat plays an important role in providing food plants, adequate living space, satisfactory soil conditions for the eggs, and favorable biotic relationships for all the life stages (Pfadt, 2002). Generally, only one generation a year is produced except in the northern regions where eggs may occasionally require as many as two years to fully develop, depending upon species and climatic conditions (Pfadt, 2002).

Once a female has mated with a male of her species, the female digs a small hole in the soil with her ovipositor and pours a frothy liquid into the hole into which her eggs are deposited one at a time (Severin and Gilbertson, 1931). The female continues to add eggs and liquid, and when finished, secretes a mass of frothy material as a plug to the hole and a cap to the egg pod (Severin and Gilbertson, 1931). Once a female begins laying eggs, she will continue to mate and deposit eggs regularly for the rest of her life (Pfadt, 2002). The number of eggs laid may range from 3 pods per week to 1 pod every 1 to 2 weeks (Pfadt, 2002), and each pod may contain as many as 8 to 153 eggs (Severin and Gilbertson, 1931). Eggs vary in size, color, and shell sculpturing, and depending on the species, range from 4 to 9 millimeters long and may be white, yellow, olive, tan, brownish-red or dark brown in color (Pfadt, 2002). Grasshopper egg pods also vary depending on species, not only in the number of eggs they contain, but also in their size, shape, structure, and where they are laid (Pfadt, 2002). For the majority of grasshopper species, eggs are laid in the soil late in the summer and fall, and overwinter as eggs (Pfadt, 2002). The embryos remain physiologically active as transfer of nutrient materials from the yolk into the embryonic fat body and tissue continues (Pfadt, 2002). Cold temperatures slow or end this process, and the embryos enter into a dormant stage for the winter. In spring, when soil temperatures warm above threshold levels of 50 to 55˚degrees Fahrenheit (˚F), the egg embryos continue their development (Pfadt, 1994; Fisher et al., 1996; Pfadt, 2002).

Newly hatched grasshoppers are quickly capable of standing upright and being able to hop away from danger. The young grasshoppers are active and begin feeding on green and nutritious host plants. A young grasshopper must shed (molt) its soft exoskeleton to grow and mature to an adult stage. As the grasshoppers grow and develop, they molt at intervals, changing their structures, such as wings and sexual organs, and form. Depending on species and sex, grasshoppers molt four to six times during their nymphal or immature life (Pfadt, 2002). Depending on weather conditions, the completion of all of the nymphal molts may require a total of 30 to 40 days (Pfadt, 2002). Mormon crickets vary from grasshoppers because they emerge in spring at lower temperatures than grasshoppers; hatching starts when soil temperatures reach 40˚F (Pfadt, 2002). They also differ in that they pass through seven nymphal instars and may take 60 to 90 days to complete their molting (Pfadt, 2002). When the final nymphal instar molts, the exoskeleton hardens and the insect becomes an adult and is ready to mate and reproduce (Pfadt, 2002).

3. *Damage Caused by Grasshoppers*

In most years, and in most locations, most grasshopper species are harmless or even beneficial to grassland ecosystems, but under certain environmental conditions outbreaks can inflict economic damage to western rangelands (Wakeland and Shull, 1936; Swain, 1944; Wakeland and Parker, 1952; Pfadt, 2002; Branson et al., 2006). Some grasshopper species eat closer to the ground than livestock and feed primarily on the growing part of grasses. Some grasshoppers cut grass stems and blades, eating only a part, such as the bigheaded grasshopper (*Aulocara elliotti*) (Pfadt, 2002). High densities of grasshoppers can destroy the value of rangeland for grazing of livestock and can result in wind and water erosion, especially when drought or land mismanagement occurs (Dibble, 1940; Hewitt, 1977; Pfadt, 1994; Pfadt, 2002). Row crops such as corn, soybeans, or small grains occur intermixed with rangeland in the northern Great Plains, and nearby row-crops may be severely damaged by grasshopper invasion from infested rangelands. Grasshoppers may also damage wildlife habitat.

Mormon crickets move in wide bands by walking or jumping, and may devour much of the forage in their path. They are destructive to range plants because they consume young plants, the flowering parts and seeds of grasses, and can defoliate larger plants and shrubs (Wakeland, 1959). Mormon crickets also damage wheat, barley, alfalfa, sweetclover, and commercial and garden vegetables (Pfadt, 2002).

Many factors influence the impact of grasshoppers on rangeland, including the presence of food, grasshopper species, grasshopper density, condition of the habitat (overgrazed, drought, etc.), grasshopper physiology (growth stage, sex), presence of predators and pathogens, and weather (rainfall and temperature) (Hewitt, 1977; Belovsky and Slade, 1995; Fielding and Brusven, 1996).

4. *Predicting Grasshopper Outbreaks*

The Program conducts region-wide surveys for both nymph and adult populations of grasshoppers in order to assist with predictions of grasshopper population levels in the following year. Ground-based surveys are used to generate maps based on a current year's infestations, and these maps serve as the only tool for "predicting" future population levels under the assumption that whatever conditions prevail in the current year are a plausible forecast of the following year, but these maps are not always reliable (Lockwood and Schell, 1995; Lockwood and Lockwood, 2008). Outbreaks are difficult to predict because the grasshopper complex is composed of multiple species, and there is likely to be at least one species in the community that can respond independently to varying environmental conditions and increase in abundance (Skinner, 2000). The ability to predict better grasshopper outbreaks would allow limited treatment resources to be acquired, allocated, and applied in an optimal manner (Lockwood and Lockwood, 2008).

5. *Surveying and Treating Grasshopper Outbreaks*

Surveys

Both nymph and adult populations of grasshoppers may be surveyed on an annual basis in States where grasshopper outbreaks are common. In States where outbreaks are not common, surveys may be required when outbreaks occur. APHIS may conduct surveys on private as well as public rangelands. Survey information is used by APHIS and land managers or owners to assess whether treatments may be warranted. The ultimate goal of the detection survey is to determine whether suppression treatments should be considered.

Delimiting surveys are conducted to determine the precise area of treatment when detection surveys have indicated the need for treatment. Information collected in the delimiting survey includes the extent of the grasshopper outbreak as well as factors such as land ownership, rangeland conditions, and sensitive sites. Post-treatment surveys are conducted after a treatment has been applied. The purpose is to determine the effectiveness of the treatment. It is important to correlate the detection and delimiting survey results with the post-treatment survey results to determine the population reduction resulting from the treatment.

Insecticide Treatments

Once APHIS receives a written request to conduct a treatment, Program personnel make a site visit to determine whether treatment is warranted by assessing various factors relevant to the infestation. These factors include, but are not limited to, the pest species, biological stage of the pest species population, timing of treatment, cost benefits of conducting the action, and ecological considerations (see footnote on page 6 for a description of economic threshold).

Currently, APHIS uses three insecticides in its grasshopper program: carbaryl, diflubenzuron, and malathion. Treatments consist of a single application of only one of these three. There are two general types of insecticide used for grasshopper control: liquid ultralow-volume (ULV) chemical sprays and insecticide-impregnated wheat-bran flakes (i.e., insecticide baits). Insecticides may be applied by ground equipment or aerially. Insecticide applications can be made at conventional rates and complete area coverage, or using reduced agent area treatments (RAATs), an approach that can result in treating less land area and/or using insecticides at lower rates. Insecticides used by the Program are currently registered for use and labeled by the U.S. Environmental Protection Agency

(USEPA) for control of rangeland grasshoppers. More information about current and proposed treatments is included in Chapter 2, Alternatives.

Before treatments are made, APHIS prepares maps of the treatment area that identify sensitive sites, such as schools, hospitals, day care centers, playgrounds, residences, campgrounds, organic crops, protected species, and surface water bodies. In areas considered for treatment, the Program notifies State-registered beekeepers and organic producers in advance of proposed treatments. The Program also notifies residents within treatment areas, or their designated representatives prior to proposed treatments. They are advised of the control method to be used, proposed method of application, and precautions to be taken. If necessary, non-treated buffer zones are established to protect these resources. A buffer zone is a distance or space around a sensitive area that will not be sprayed to minimize harm and disturbance of that area. For instance, buffer zones for federally listed plants are important to protect any insect pollinators that might be necessary for reproduction of the plants (Winks et al., 1996). APHIS monitors sensitive sites to demonstrate the effectiveness of procedures to exclude or minimize exposure of people and the environment to Program-applied treatments.

e. Public Involvement

1. *Environmental Assessments*

APHIS has prepared many yearly, state-specific environmental assessments (EAs) regarding grasshopper management in the 17 Western States. APHIS conducts surveys to help determine general treatments areas, among the scores of millions of acres that potentially could be affected, where grasshopper infestations may occur in the spring of the following year. However, there is considerable uncertainty in the forecasts, so that framing specific grasshopper control projects for analysis under NEPA months in advance is not possible. At the same time, the Program strives to alert the public in a timely manner to its general treatment plans and avoid or minimize harm to the environment in implementing those plans.

The Program will prepare a draft EA for each of the 17 Western States, or portion of a state, that may receive a request for treatment. The draft EA analyzes aspects of environmental quality that could be affected by grasshopper treatment. The draft EA is tiered to the current EIS. The draft EA is made available to the public for a 30-day comment period. When the Program receives a treatment request and determines that treatment is necessary, the specific site within the state will be evaluated to determine if environmental issues exist that were not covered in the draft EA. If all environmental issues were covered in the draft EA the program will prepare a Final EA and FONSI and send copies of those documents to any parties that submitted comments on the draft EA and other appropriate stakeholders. To allow the Program to respond to requests in a timely manner the final EA and FONSI will then be posted to the APHIS website and the program will publish a notice of availability in the same manner used to advertise the availability of the Draft EA. Also, prior to each treatment season, APHIS conducts meetings or provides guidance that allows for public participation in the decision making process.

2. *Other Methods of Public Notification*

When there is evidence that a control program may take place, public meetings may be organized. The purpose of the meetings is to inform and receive comment from land managers and other stakeholders including the public; and to cooperate with the State and other agencies in planning and implementing control activities on private and public administered lands. A public meeting may be useful when parties are interested in organizing cooperative control activities or requesting information, or historical evidence indicates that an outbreak is likely to occur. Meetings are advertised to the public and cooperators through newspapers or the radio. Rancher meetings are necessary when a rancher cost share will be required for treatments on private land.

APHIS Program managers ensure that State-registered beekeepers are notified about any anticipated insecticide treatment. If a beekeeper is operating within or near the treatment area, the APHIS Program manager arranges with the beekeeper to protect their bees.

3. *Scoping for this Environmental Impact Statement*

Scoping is an open and early process to determine the issues to address in an EIS, and to identify significant issues related to the proposed action covered in the EIS. As part of this process, APHIS sent out letters to all federally recognized tribal nations in the 17 Program states, to provide information about the Program and provide contact information for any questions or concerns regarding the Program and EIS. APHIS also held a teleconference with interested tribes on March 30, 2016, to address any questions about the Program and EIS process. On September 1, 2016, APHIS published a notice of intent (NOI) in the *Federal Register* (FR) describing its intent to prepare a programmatic EIS for the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program (Docket No. APHIS-2016-0045). The public was invited to submit public comments to further delineate the scope of the alternatives and environmental impacts and issues for the proposed EIS.

In the NOI, APHIS identified the following environmental resources requiring further examination in this EIS:

- Effects on wildlife, including consideration of migratory bird species and changes in native wildlife habitat and populations, and federally listed endangered and threatened species;
- Effects on soil, air, and water quality;
- Effects on human health and safety;
- Effects on cultural and historic resources; and
- Effects on economic resources.

APHIS made available a press release regarding the NOI to media contacts through the APHIS Stakeholder Registry that contains almost 12,000 contacts. In addition, APHIS conducted the following notification activities:

- Notification to tribal contacts;
- Notification to U.S. Fish and Wildlife Service (USFWS) contacts;
- Notification to various partners and organizations, such as:
    - APHIS–Plant Protection and Quarantine (PPQ) State Plant Health Directors in the seventeen Program states.
    - State agricultural agencies.

APHIS received 12 comment letters during the 45-day scoping period. APHIS considered all comments in the planning of this EIS. Issues and concerns identified by the public and tribal contacts included:

- Consideration of methods such as Integrated Pest Management, and nonchemical methods such as natural predators and fungal agents of grasshoppers
- Mitigation measures for beekeepers, schools, and sensitive populations
- Toxicity and environmental consequences of insecticides proposed for use
- Effects on threatened and endangered species
- Effects on agricultural crops
- Effects on livestock (sheep, cattle horses, burros) grazing in areas where insecticides are applied
- Effects on air, soil, and water (including drinking water, source water, and ground water, and compliance with the Clean Water Act)
- Effects in native vs. non-native (including invasive) species
- Direct, indirect, and cumulative impacts from insecticide use to biological and ecological resources such as biodiversity of grassland birds, non-target arthropods (including pollinators), freshwater invertebrates, fish, and predator populations
- Synergistic and chronic effects of insecticides
- Benefits of native grasshopper populations
- Aesthetic, historic, cultural, economic, social, ethnobotanical, soundscape, view shed, and health impacts

- Impacts on organic farms
- Impacts on children and minority and low-income populations
- Impacts on Tribes (health, natural, and cultural resources)
- Impacts on designated Wilderness Areas
- Impacts on national historic trails
- Cost/benefit analysis of the proposed program
- Conducting risk assessments tailored to each U.S. ecoregion
- Effects of climate change on species and ecosystems

Some comments did not raise specific issues for analysis in this EIS; however, opinions were provided for and against the selection of certain Program control methods. APHIS and its cooperators recognize the public's concern about the potential impacts of Program activities on human health, biological resources, and the physical environment. Part of this EIS will address these concerns.

On January 30, 2019 APHIS published the draft EIS in the Federal Register and notified interested parties of its availability through a stakeholder registry and other resources. APHIS received 19 public comments in response to publication of the draft EIS. General comments were received from the public supporting and opposing efforts by APHIS to suppress grasshopper and Mormon cricket populations. Public comments were received from the County Duchesne Commission, two State agencies (Nevada Department of Agriculture and Wyoming Game and Fish Agency), two Federal agencies (U.S. Environmental Protection Agency (EPA) and the Department of the Interior (DOI)), the registrants for carbaryl, malathion and chlorantraniliprole; five non-governmental agencies including the Center for Biological Diversity, South Dakota Stock Growers Association, Association of National Grasslands, Xerces Society and Pollinator Stewardship Council; and interested public citizens. APHIS' response to the public comments are located in Appendix B.

f. Decision Framework

A Rangeland Grasshopper Cooperative Management Program, Final Environmental Impact Statement—1987 (1987 EIS) (USDA APHIS, 1987) was prepared to study the feasibility of using integrated pest management (IPM) for managing grasshoppers. IPM includes biological control, chemical control, rangeland management, environmental monitoring and evaluation, modeling and population dynamics, and decision support tools. The major objectives of the Program were to (1) manage grasshopper populations in study areas, (2) compare the effectiveness of an IPM program for rangeland grasshoppers with the effectiveness of a standard chemical control program on a regional scale, (3) determine the effectiveness of early sampling in detecting incipient grasshopper infestations, (4) quantify short- and long-term responses of grasshopper populations to treatments, and (5) develop and evaluate new grasshopper suppression techniques that have minimum effects on non-target species (Quinn, 2000). The techniques outlined in the preferred alternative of that EIS included providing more detailed surveys of grasshopper populations so that small areas of infestations could be defined, treating small areas of infestations ("hot spots") rather than the larger areas of infestation traditionally treated, and using control methods other than the conventional large-scale aerial applications of insecticidal sprays.

Since the preparation of the 1987 EIS, new information and technological advances in insecticide treatments for grasshopper infestations occurred. Thus, in 2002, an EIS was prepared to revise the 1987 analysis of the potential for environmental impacts from the insecticides used for rangeland grasshopper control because updated information about the potential impacts from carbaryl and malathion on human health and non-target species became available. APHIS removed the insecticide acephate as a grasshopper suppression tool because the Environmental Protection Agency (USEPA) registration for its use on rangeland was not renewed. In addition, the insecticide diflubenzuron was proposed for addition to the Program as a tool to control rangeland grasshoppers, and an alternative treatment strategy, referred to as RAATs, for grasshopper suppression was researched and developed. This strategy allowed application of an insecticide treatment at a reduced rate, in alternating land swaths, or both, thus resulting in reduced insecticide use.

Because of new proposed Program tools and methods, APHIS is revising the 2002 EIS. Listed below are three alternatives for further examination in this EIS. Chapter 2 describes the alternatives in greater detail.

1. No action. Under this alternative, APHIS would maintain the Program that was described in the 2002 EIS and Record of Decision. This alternative represents the baseline against which a proposed action may be compared.

2. No suppression program. Under this alternative, APHIS would not fund or participate in any program to suppress grasshopper outbreaks. APHIS may opt to provide technical assistance, but any suppression program would be implemented by a Federal land management agency, a State agriculture department, a local government, or a private group or individual.

3. Insecticide applications at conventional rates or reduced agent area treatments with adaptive management strategy (preferred alternative). Under this alternative, APHIS would update new information and technologies that were analyzed in the 2002 EIS. The insecticides available for APHIS use include the USEPA-registered chemicals carbaryl, diflubenzuron, chlorantraniliprole, and malathion. Carbaryl and malathion are cholinesterase inhibitors which affect the nervous system. Diflubenzuron is an insect growth regulator that acts by inhibiting chitin production. Chlorantraniliprole affects the nervous

system by activating ryanodine receptors in insects. APHIS would apply one insecticide to a treatment area at the APHIS conventional rate used for grasshopper suppression treatments, or apply as RAATs. The RAATs strategy uses a reduced rate of insecticide from conventional levels by alternating treatment swaths in a spray block, reduced application rates, or both. The RAATs strategy suppresses grasshoppers within treated swaths, while conserving grasshopper predators and parasites in swaths that are not treated. An adaptive approach of either conventional rates or RAATs will allow the Program to make site-specific suppression applications using a range of application rates to ensure adequate suppression.

APHIS will not implement site-specific suppression projects as a direct result of the decision that will follow this EIS. Rather, APHIS will prepare site-specific EAs before the agency decides to implement any grasshopper management project. EAs will address unique local issues, beyond the scope of this document, for site-specific management projects for grasshoppers. Site-specific EAs are more detailed and precise as to geographical locations and strategies appropriate for the type of outbreak. The decision on this EIS will serve as the primary guide for management of grasshoppers in the 17 Western States. The decision whether to plan or implement a grasshopper management project will occur on a case-by-case basis by APHIS and its cooperators.

g. Scope of this Document and NEPA Requirements

This EIS addresses the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program, directly or in conjunction with others (States, other Federal agencies, tribal governments, and private individuals). This EIS provides an overview of insecticides and approaches available to APHIS for grasshopper suppression during outbreaks and the potential for environmental impacts from their uses. This EIS can be used as a basis for tiering site-specific EAs when APHIS is requested to suppress grasshopper outbreaks. In addition, Federal land management agencies can use this information when preparing their environmental documents. They can adopt, combine, incorporate by reference, or tier their activities to the data and analysis in this EIS. Research and methods development activities are outside the scope of this document and were not examined.

h. Consultations

Section 7 of the Endangered Species Act (ESA) and its implementing regulations require Federal agencies to ensure their actions are not likely to jeopardize the continued existence of threatened and endangered species, or result in the destruction or adverse modification of critical habitat. APHIS has completed a programmatic consultation with the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) for the Program (concurrence letter dated (August 12, 2010)). APHIS has initiated a programmatic consultation with the Department of Interior's U.S. Fish and Wildlife Service (USFWS) and will continue to coordinate with the USFWS to complete the programmatic biological assessment for the 17 Program states that was submitted in March 2015. Until the programmatic consultation with USFWS is completed, each Program state conducts yearly Section 7 consultations with USFWS, Ecological Services Field Offices within their state.

In past grasshopper programs, the BLM or BIA have notified the appropriate APHIS State Plant Health Director when any new or potentially threatening grasshopper infestation is discovered on BLM lands or tribal lands held in trust and administered by BIA. APHIS has cooperated with BIA when grasshopper programs occur on Native American tribal lands. In grasshopper programs involving Native American populations, APHIS Program managers work with BIA and contacts established under the APHIS Office of the National Tribal Liaison to communicate information to tribal organizations and representatives when programs have the potential to impact the environment of their communities, lands, or cultural resources. Consultation with local Tribal representatives take place prior to treatment programs to fully inform the Tribes of possible actions APHIS may take on Tribal lands (USDA APHIS, 2016a).

In addition, APHIS will ensure that site-specific evaluations will be done, as necessary, under the National Historic Preservation Act, Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and any other laws, regulations, Executive orders, and agency policies that apply to site-specific projects.

II. Alternatives

This EIS analyzes the potential environmental consequences associated with the alternative options to suppress grasshopper populations in areas of the contiguous United States, namely, the seventeen Western States most affected (Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming). The purpose of the alternatives is to describe the reasonable strategies the agency could take to achieve its goal of suppressing rangeland grasshopper populations.

APHIS conducts survey activities, provides technical assistance, and may make insecticide treatments according to the agency's authority under the Plant Protection Act (Figure 1-1). Surveys are part of each alternative proposed, and are not unique to any one alternative. Therefore, descriptions for these surveys are independent from the descriptions for each alternative.

Similarly, APHIS technical guidance is part of each alternative proposed, and is not unique to any one alternative. An example of APHIS technical guidance is the agency's work on integrated pest management (IPM) for the grasshopper program. IPM is defined as a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks (7 U.S. Code 136r-1). IPM for grasshoppers includes biological control, chemical control, rangeland and population dynamics, and decision support tools.

APHIS has funded the investigation of various integrated pest management (IPM) strategies for the grasshopper program. Congress established the Grasshopper Integrated Pest Management (GIPM) to study the feasibility of using IPM for managing grasshoppers.

The major objectives of the APHIS GIPM program were to: 1) manage grasshopper populations in study areas, 2) compare the effectiveness of an IPM program for rangeland grasshoppers with the effectiveness of a standard chemical control program on a regional scale, 3) determine the effectiveness of early sampling in detecting developing grasshopper infestations, 4) quantify short- and long-term responses of grasshopper populations to treatments, and 5) develop and evaluate new grasshopper suppression techniques that have minimal effects on non-target species (Quinn, 2000).

The results for the GIPM program have been provided to managers of public and private rangeland and are available at: www.sidney.ars.usda.gov/grasshopper/index.htm. The website provides information on ways to manage grasshopper populations in the long-term, such as livestock grazing methods and cultural control by farmers. In addition, APHIS issued the GIPM User Handbook, available at the following website: https://www.sidney.ars.usda.gov/grasshopper/Handbook/index.htm. The handbook covers biological control, chemical control, environmental monitoring and evaluating, modeling and population dynamics, rangeland management, decision support tools, and future directions.

Federal and State land management agencies, State agriculture departments, and private groups or individuals may carry out a variety of preventative IPM strategies that may reduce the potential for grasshopper outbreaks. Some of these activities include grazing management practices, cultural and mechanical methods, and prescribe-burning of rangeland areas. These techniques have been tried with varying success in rangeland management, and some have been associated with the prevention, control, or suppression of harmful grasshopper populations on rangeland. Additionally, landowners often conduct grasshopper treatment activities independent from APHIS. These treatments may include the use of insecticides at label rates and frequencies higher than those used by the Program, or landowners may apply labeled insecticides that the Program does not use which could result in increased risk to the environment.

Regardless of the various IPM strategies taken, the primary focus of this EIS is on the potential impacts from immediate chemical treatment needs during an outbreak of economic importance. While APHIS provides technical expertise regarding grasshopper management actions, the responsibility for implementing most land management practices lies with other Federal (i.e., BIA, BLM, and USDA's FS), State, and private land managers (for more details, see section titled "Who has authority to act?" in chapter 1). The best grasshopper management strategies are preventative in nature and are long-term efforts that are designed to head off, rather than combat, outbreaks. However, such strategies do not achieve rapid reduction of grasshopper populations that are needed when a devastating outbreak occurs.

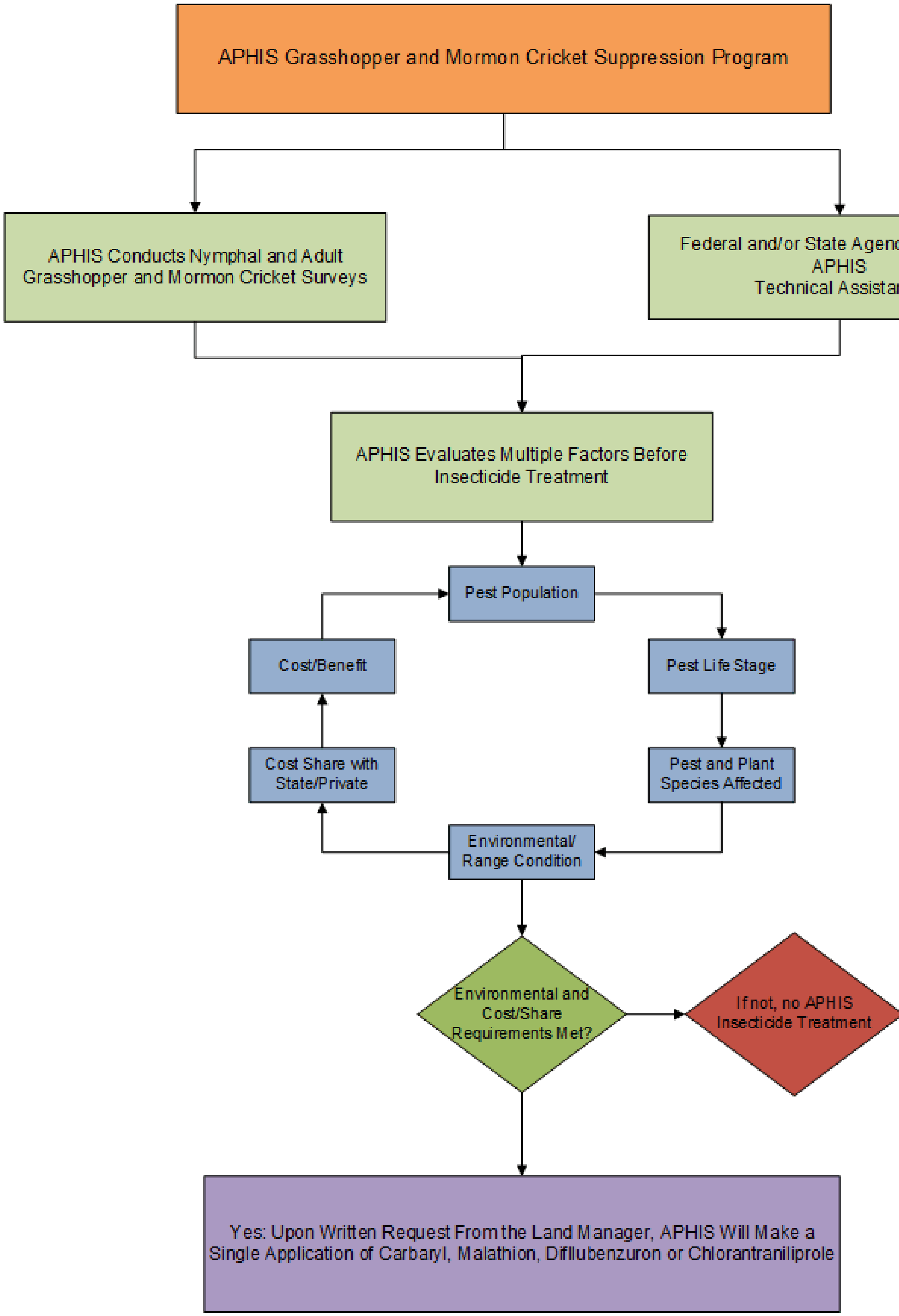

Figure 1-1. USDA-APHIS proposed activities related to the Grasshopper/Mormon Cricket Suppression Program

The following alternatives describe the options available to APHIS in fulfilling its mandate to carry out suppression programs for grasshopper and Mormon cricket infestations to protect rangeland.

A. No action. Under this alternative, APHIS would maintain the Program that was described in the 2002 EIS and Record of Decision. The insecticides that are currently available for use include carbaryl, diflubenzuron, and malathion. These products can be applied using ground or aerial equipment at APHIS full coverage rates or by using RAATS.

B. No suppression program. Under this alternative, APHIS would not fund or participate in any program to suppress grasshopper infestations. APHIS may opt to provide technical assistance, but any suppression program would be implemented by a Federal land management agency, a State agriculture department, a local government, or a private group or individual.

C. Insecticide applications at conventional rates or reduced agent area treatments (RAATs) with adaptive management strategy (preferred alternative). Under this alternative, the information and technologies that were analyzed in the 2002 EIS would be updated. The insecticides available for use by APHIS include the USEPA-registered chemicals carbaryl, diflubenzuron, and malathion and a new product, chlorantraniliprole (table 2-1). These chemicals have varied modes of action: carbaryl and malathion work by inhibiting acetylcholinesterase (AChE); diflubenzuron is a chitin inhibitor; and chlorantraniliprole is an activator of ryanodine receptors. Upon request APHIS would make a single application per year to a treatment area, and would apply it at an APHIS rate conventionally used for grasshopper suppression treatments, or as a reduced agent area treatment (RAATs). The identification of specific pests and their life stage determines the choice of insecticides used among those available to the Program. The use of RAATs is the most common application method for all Program insecticides and would continue to be unless pest conditions warrant full coverage and higher rates.

Table 2-1. Characteristics of Insecticides Used by the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program

Insecticide	Mode of Action	Application Rates* (lb a.i./acre)	Total Volume Applied	Program Use	Comments
Carbaryl ULV spray/Sevin® XLR Plus	AChE Inhibitor	0.50 conventional 0.25 RAATs	Conventional: 32 fl. oz. per acre (carbaryl and water in 1:1 ratio) RAATs – ½ conventional	Effective against grasshoppers and crickets season-long; can be used in wet and cool conditions	Currently used less often than dimilin, but more often than malathion; has longer residual than malathion
Carbaryl bait (solid formulation)	AChE Inhibitor	0.50 conventional (5% formulation) 0.20 RAATs (2% formulation)	Conventional and RAATS: 10 lb/acre of bran flakes, apple pumice	Effective for crickets, but not consumed by all grasshoppers; can be used season-long	Little drift when applied; used mostly for crickets who consume bait almost immediately
Chlorantraniliprole/ Prevathon®	Ryanodine Receptor Activator	0.02 conventional 0.013 RAATs	Conventional: 32 fl. oz. per acre/8 fl. oz. per acre (Prevathon) RAATs: ½ conventional	Effective after egg hatch against 2nd and 3rd instar nymphs	New proposed insecticide not currently registered in all 17 Program states
Difluenzuron ULV spray/Dimilin® 2L	Insect Growth Regulator	0.016 conventional 0.012 RAATs	Conventional: 31 fl. oz. per acre (1 part diflubenzuron, 20 parts water, 10 parts clean crop oil or vegetable oil)	Effective only against immature grasshoppers and crickets; early-season use, only	Most commonly used spray; slow acting, takes a week or longer to notice effects
Malathion ULV spray/Fyfanon® ULV	AChE Inhibitor	0.62 conventional 0.31 RAATs	Conventional: 8 fl. oz. per acre RAATs – ½ conventional	Effective against grasshoppers and crickets season-long; favorable for dry and hot conditions	Historically was insecticide most commonly used, but not used much in recent years; used when a fast-acting result is needed; very little residual

*Note: only one of these insecticides would be applied, and only one application would be made in any location in any given year. Conventional rates refer to maximum APHIS rates.

RAATs can decrease the rate of insecticide applied by either using lower insecticide concentrations or decreasing the deposition of insecticide applied by alternating one or more treatment swaths. Both options may be incorporated simultaneously. The RAATs strategy suppresses grasshoppers within treated swaths, while conserving grasshopper predators and parasites in swaths that are not treated. The viability of this method at operational scales was initially demonstrated by Lockwood *et al.* (Lockwood et al., 2000; Lockwood and Latchininsky, 2000). Applications can be made either aerially or with ground-based equipment (Deneke and Keyser, 2011). Studies using the RAATs strategy have shown good control (up to 85% of that achieved with a traditional blanket insecticide application) at a significantly lower cost and less insecticide, and with a markedly higher abundance of non-target organisms following application (Lockwood et al., 2000; Deneke and Keyser, 2011). Levels of control may also depend on variables such as body size of targeted grasshoppers, growth rate of forage, and the amount of coverage obtained by the spray applications (Deneke and Keyser, 2011). Control rates may also be augmented by the necrophilic and necrophagic behavior of grasshoppers, in which grasshoppers are attracted to volatile fatty acids emanating from cadavers of dead grasshoppers and move into treated swaths to cannibalize cadavers (Lockwood et al., 2002; Smith and Lockwood, 2003). Under optimal conditions, RAATs decrease control costs, as well as host plant losses and environmental effects (Lockwood et al., 2000; Lockwood et al., 2002).

The approach of utilizing either conventional APHIS rates or RAATs will allow the Program to make site-specific suppression applications using a range of application rates to ensure adequate suppression. The Program would add other treatment(s) that may become available in the future for managing grasshoppers to currently approved treatments, referred to as adaptive management. A new treatment would be available for use upon APHIS finding that the treatment is registered by the USEPA for use on grasshoppers, and poses no greater risks to human health and non-target organisms than the risks associated with the currently approved treatments evaluated in this EIS. The protocol for making the necessary finding that a treatment is authorized by this alternative is as follows:

1. Conduct a human health and ecological risk assessment (HHERA). In this risk assessment, APHIS would conduct a review of scientific studies for toxicological and environmental fate information relevant to effects on human health and non-target organisms. APHIS uses this information to estimate the risk to human health and non-target organisms. A HHERA includes the following four elements: (a) hazard evaluation, (b) dose response assessment, (c) exposure assessment, and (d) risk characterization. The HHERA will:

   - Identify potential use patterns, including formulation, application methods, application rate, and anticipated frequency of application

- Review hazards relevant to the human health risk assessment, including direct toxicity, skin and eye irritation, dermal sensitization, dermal absorption, developmental and reproductive toxicities, carcinogenicity, neurotoxicity, immunotoxicity, and endocrine disruption
- Evaluate the dose response of chemicals permitted for APHIS use
- Estimate the potential for exposure of workers applying the chemical
- Estimate the potential for exposure to members of the public
- Characterize environmental fate and transport, including drift, leaching to ground water, and runoff to surface streams and ponds
- Review available ecotoxicity data, including hazards to mammals, birds, reptiles, amphibians, fish, and aquatic invertebrates
- Estimate exposure of terrestrial and aquatic wildlife species
- Characterize risk to human health and wildlife

2. APHIS will conduct a comparison of the human health and ecological risks of a new treatment with the risks identified for the currently authorized treatments. This risk comparison will evaluate quantitative expressions of risk (such as hazard quotients), and qualitative expressions of risk that put the overall risk characterizations into perspective. Qualitative factors include scope, severity, and intensity of potential effects, as well as temporal relationships, such as reversibility and recovery.

3. If the risks posed by a new treatment fall within the range of risks posed by the currently approved treatments, APHIS will publish a notice in the *Federal Register* of its preliminary findings that the treatment meets the requirements of this alternative. The notice must provide a 30-day public review and comment period, and must advise the public that the HHERA and the risk comparison are available upon request.

4. If consideration of public comments leads to the conclusion that the preliminary finding is correct, APHIS will publish a notice in the *Federal Register* that the treatment meets the requirements of this alternative and, therefore, is authorized by this alternative for use in the Grasshopper and Mormon Cricket Suppression Program. APHIS will make available to anyone, upon request, a copy of the comments received and the agency's responses. Use of any new insecticide evaluated using this method would also be evaluated in a site specific EA.

a. Alternatives Considered but not Included in this EIS

Use of Mycoinsecticides

Certain fungi are natural pathogens of grasshoppers, including *Metarhizium anisopliae*, *M. brunneum*, and *Beauveria bassiana*. When fungi are used to control insects, they are called mycoinsecticides. Most of these fungi synchronize their life cycles with insect host stages and environmental conditions (Shah and Pell, 2003). In the United States, *B. bassiana* is registered by the USEPA for use against grasshoppers; *M. anisopliae* and *M. brunneum* are not. Formulations can be sprayed or applied in bait form (Tounou et al., 2008).

Mycoinsecticides usually work by increasing the levels of cellular enzymes in the target insect, particularly P450 esterase and glutathione-S-transferase, which affects spore proliferation (Bitsadze et al., 2013). Once the grasshopper is killed, production of spores and conidia continue on the outside of the cadaver, and may be passively dispersed to other, live grasshoppers (Shah and Pell, 2003). Some studies have examined the effect of applying diflubenzuron together with a mycoinsecticide and found heightened efficacy (Bitsadze et al., 2013). The mechanism by which diflubenzuron increases efficacy of fungal pathogens is not well understood. It is thought that, in weakening the cuticle of the insect, diflubenzuron makes it easier for fungal spores to gain entrance into the hemolymph (Shah and Pell, 2003; Bitsadze et al., 2013). An advantage of mycoinsecticides is their low effect on non-target organisms (Shah and Pell, 2003).

However, APHIS is not considering the use of mycoinsecticides in this programmatic EIS because their use still has many disadvantages, and their production has many technical problems, including high costs (Fang et al., 2014). A major criticism has been that mycoinsecticides act too slowly (Bitsadze et al., 2013; Pelizza et al., 2015), allowing grasshoppers to disperse into untreated areas (Lomer et al., 2001). Speed of control may also be complicated by below-freezing temperatures at night in some treatment areas, which delay fungal development (Lomer et al., 2001). A significant impediment is that Mormon crickets do not appear to be effectively controlled by mycoinsecticides (Foster et al., 2010). Efficacy with grasshoppers is unpredictable as well, with variable effects depending on the spore and formulation types used (Foster et al., 2011). Perhaps the biggest drawback is due to the thermoregulatory behavior of grasshoppers: basking in sunlight to warm up hemolymph before locomotion (Rangel et al., 2010). Sunlight inactivates fungi (Pelizza et al., 2015), effectively stopping the fungal infection. Temperatures above 35-40 degrees Celsius (°C) appear to halt fungal growth, although there is the potential for some fungal isolates to recover and continue to grow (Rangel et al., 2010). Therefore, use of fungi as a biological control method against grasshoppers is restricted to geographical areas in which ambient temperatures do not rise above 35-40°C.

Lastly, there have been technical problems with the mass production of mycoinsecticides and the stability of the formulations for storage (Shah and Pell, 2003; Kassa et al., 2004).

Use of Microsporidia

Microsporidia are unicellular parasites that form spores. *Paranosema locustae* (also known as *Nosema locustae*) is most commonly used against grasshoppers, causing chronic infections in affected insects with sublethal effects such as reduced feeding, development, typical aggregation behavior, fecundity, and longevity. There are several USEPA-registered microsporidia products currently on the market (Royer and Rebek, no date,). The effects of microsporidia on grasshoppers tend to accumulate over time, eventually causing mortality (Lange and Cigliano, 2010; Bjornson and Oi, 2014). Grasshoppers must ingest microsporidia in order to become infected (Tounou et al., 2008). Infected grasshoppers may also transmit microsporidia through cannibalism and necrophagy of treated grasshoppers, or transovarially. Third-instar nymphs appear to be most vulnerable to *P. locustae* infection and mortality. However, efficacy is hampered by the lack of acute infections which cause rapid mortality, so control is difficult to achieve with the use of microsporidia alone, and populations do not decline quickly enough for microsporidia to be a viable option (Bjornson and Oi, 2014). An additional drawback is that *P. locustae* is not effective against Mormon crickets (Foster et al., 2011).

III. Potential Environmental Impacts

a. Introduction

This chapter discusses and compares the potential environmental impacts associated with the three alternative actions:

> Alternative 1, No action: APHIS would maintain the Program that was described in the 2002 Rangeland Grasshopper and Mormon Cricket Suppression Program, Final EIS and Record of Decision (ROD). A single application per season of one of the following insecticides would be used: carbaryl, diflubenzuron, or malathion. The Program usually applies any of the three insecticides using RAATs. The Program applies the chemicals using aerial or ground applications either as a spray or as baits (i.e., insecticide-impregnated wheat-bran flakes).

> Alternative 2, No suppression program: APHIS would not fund or participate in any program to suppress grasshopper outbreaks; however, other groups could implement suppression programs.

> Alternative 3, Insecticide applications at conventional APHIS rates or reduced agent area treatments (RAATS), with adaptive management strategy (preferred alternative): APHIS would continue the current Program as outlined under the no action alternative, with modifications. The Program would add chlorantraniliprole to the list of insecticides as well as the adaptive management strategy, as described in chapter 2.

The primary focus of this chapter will be the potential environmental impacts from the application of the above-mentioned chemicals on rangelands, which includes the potential impacts of the various application methods (i.e., bait versus spraying, aerial applications versus ground applications, and traditional treatments versus RAATs). APHIS could potentially conduct surveys and provide technical expertise under each alternative. However, these actions would fall under "routine measures", have little impact on the human environment, would categorically be excluded under 7 CFR part 372.5 of APHIS' NEPA Implementing Procedures, and will not be discussed any further in this chapter.

APHIS is only considering the use of carbaryl, diflubenzuron, malathion, and chlorantraniliprole for grasshopper suppression based on effective performance against grasshoppers on rangeland, and minimal or negligible impact on the environment and non-target species (Reuter and Foster, 1996). A number of other products and insecticides are labeled for use against grasshoppers on rangeland but are not being considered for use at this time because of efficacy, economic or environmental concerns. There would be a chance for APHIS to consider the use and impacts of new insecticides in the Program under the adaptive management alternative; this option will be discussed later under the adaptive management alternative section within this chapter.

Current conditions of the human environment, which 40 CFR part 1508.14 defines as the natural and physical environment and the relationship of people with that environment, in which grasshopper suppression may take place are also included in this chapter. These conditions will serve as a baseline so that relevant comparisons can be made among the three alternatives.

Human environmental issues that will be addressed for each alternative include the physical environment (air, water, and soil), vegetation, and the health of livestock, wildlife, and humans. There is also a separate discussion on environmental justice and children issues, tribal issues, fires and human health hazards, threatened and endangered species, migratory birds, bald and golden eagles, others species of concern, National Pollutant Discharge Elimination System (NPDES) permits, cultural and historical resources, and cumulative impacts.

Because this is a programmatic EIS, the descriptions of the potential environmental impacts are general. Suppression efforts can occur on rangeland within 17 western states: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. While chemical treatment could occur on rangeland, other surrounding land types, such as surrounding crop lands, could be impacted. The physical environment and other conditions among and within the various states vary so dramatically that it would be impossible to analyze specific impacts of each alternative within each of the 17 states. Therefore, when grasshopper populations have reached a level at which a request has been made to APHIS to chemically treat, and funding is available, APHIS will write a site-specific EA to analyze potential site-specific environmental impacts. The potentially impacted areas would be identified and outlined at that time. For examples of previously written site-specific grasshopper EAs, see the following website: https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/sa_environmental_assessments/ct_grasshopper_cricket.

APHIS has written human health and ecological risk assessments (HHERAs) to assess the insecticides and use patterns that are specific to the Program. The risk assessments provide an in-depth technical analysis of the potential impacts of each insecticide to human health; and non-target fish and wildlife along with its environmental fate in soil, air, and water. The assessments rely on data required by the U.S. Environmental Protection Agency (USEPA) for pesticide product registrations, as well as peer-reviewed and other published literature. The HHERAs are heavily referenced in this chapter. The documents can be found at the following website:

http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019).

b. Potential Environmental Impacts

Alternative 1. No Action

The no action alternative would maintain the Program that was described in the 2002 Final EIS and ROD. Under this alternative, there would be no new treatment options. The environmental consequences to the physical environment, human health, vegetation, wildlife, and socioeconomics would be similar to those described in the 2002 Programmatic EIS; however, information provided in the 2002 EIS has been updated below to reflect the most recent data available.

The potential risks associated with each chemical and the mitigations per label requirements as well as additional mitigations that the Program imposes, are outlined under each chemical. Potential benefits from using Program treatment techniques or strategies such as baits versus sprays and RAATS versus conventional treatments, which is expected to decrease the risks of potential impact, are discussed directly below in the section titled, “Potential Impacts of Program Treatment Techniques and Strategies”.

Potential Impacts of Program Treatment Techniques and Strategies

a. Baits versus Sprays, Aerial versus Ground

The Program applies insecticides as liquid ULV sprays or solid-based baits. Depending on the treatment area, both forms have advantages and disadvantages. Habitat diversity, topographical features, meteorological conditions, economic concerns, and environmental considerations all have important roles in choosing the best form of treatment (Foster and Onsager, 1996). The Program can distribute both ULV sprays and baits through aerial or ground applications. Aerial applications are typical for treatments over large areas. Some grasshopper outbreak locations are economically or logistically accessible only by aircraft, while other locations may be best treated by ground applications. Ground applications are most likely to be made when treating localized grasshopper outbreaks or for treatments where the most precise placement of insecticide is desired. There is more control over where the chemical is dispersed when using ground applications.

Baits have been used for grasshopper control since the late 1800s (Foster, 1996). In general, baits have environmental advantages over liquid insecticide applications. Compared to sprays, baits are easier to direct toward the target area, are much more specific toward grasshoppers, act primarily through ingestion, and affect fewer non-target organisms than sprays (Peach et al., 1994; Foster, 1996; Latchininsky and VanDyke, 2006).

The baits have a carrier, such as bran, that absorbs the insecticide, making it less bioavailable, particularly in dermal exposures (USDA APHIS, 2015). Some baits include additives to preserve the bait (e.g., silica gel) or provide an attractive carrier to the grasshoppers (e.g., n-amyl acetate). The primary concerns with silica gel relate to human inhalation of dusts (potential for silicosis). The concentration of silica gel is very low in the formulation. Proper application and adherence to pesticide labels preclude any concern for human exposures to silica gel. N-amyl acetate or "banana oil" can be used as a solvent and flavor additive. It occurs naturally in fruits. N-amyl acetate readily volatilizes to the atmosphere. Biodegradation occurs readily in soil, but there is moderate potential for bioconcentration in aquatic organisms. This is unlikely to occur due to the application buffers from aquatic sites and the lack of significant drift due to the large bait size used during application.

ULV applications are insecticide rates that are lower than the conventional rates specified on the label. Specifically, ULV applications are defined as any application of 0.5 gallon or less per acre of insecticide in liquid form. Liquid sprays, especially when applied at ULV rates, have several desirable characteristics when considering grasshopper suppression. For example, liquid applications typically produce a quicker, higher, and more predictable grasshopper mortality rate than bait applications (Fuller et al., 1996). Generally, contract costs are substantially lower for applying ULV sprays compared to conventional liquid application rates and bait applications because ULV sprays use less product (Foster and Onsager, 1996).

When applying ULV treatments, it is vital to control spray distribution to avoid drift and minimize off-target movement of material (Sanderson and Huddleston, 1996). Drift can become a critical factor in protecting environmentally sensitive areas. Drift is also unsatisfactory from a Program standpoint because drift results in less insecticide landing in the treatment area, which reduces Program efficacy.

Various spray carriers and adjuvants may be required under the label for different uses for each product; however, the carrier most often used in the Program is either natural or synthetic oils. One adjuvant that may be used with insecticides considered for use by APHIS is canola oil. The maximum rate that oil would be applied for any grasshopper suppression application is 10 ounces of oil per acre. The risk of effects from oil at this rate when considering the proposed mitigation measures is considered to be low.

b. RAATs

The RAATs strategy reduces the treatment area, the application rate of insecticides, or both. The concept of reducing the treatment area of insecticides while also applying less insecticide per treated acre was developed in 1995, with the first field tests of RAATs in Wyoming (Lockwood and Schell, 1997).

The use of RAATS is the most common application method for all Program insecticides and would continue to be unless pest conditions warrant full coverage and higher rates. The goal of the RAATs strategy is to economically and environmentally suppress grasshopper populations to a desired level, rather than to reduce those populations to the greatest possible extent.

The efficacy of a RAATs strategy in reducing grasshoppers is, therefore, less than conventional treatments and more variable. Foster et al. (2000) reported that grasshopper mortality using RAATs was reduced 2 to 15% from conventional treatments, depending on the insecticide, while Lockwood et al. (2000) reported 0 to 26% difference in mortality between conventional and RAATs-treated areas.

Insecticides suppress grasshoppers within treated swaths, yet RAATs reduces cost and conserves non-target biological resources (including predators and parasites of grasshoppers, as well as beneficial grasshoppers) in untreated areas. The potential economic advantages of RAATs was proposed by Larsen and Foster (1996), and empirically demonstrated by Lockwood and Schell (1997). Widespread efforts to communicate the advantages of RAATs across the Western States were undertaken in 1998, and have continued on an annual basis. The viability of RAATs at an operational scale was initially demonstrated by Lockwood et al. (2000), and subsequently confirmed by Foster et al. (2000). The first government agencies to adopt RAATs in their grasshopper suppression programs were the Platte and Goshen County Weed and Pest Districts in Wyoming; they also funded research at the University of Wyoming to support the initial studies in 1995. This method is now commonly used by government agencies and private landowners in States where grasshopper control is required.

With less area being treated, more beneficial grasshoppers and pollinators survive treatment. There is no standardized percentage of area that is left untreated. The proportion of land treated in a RAATs approach is a complex function of the rate of grasshopper movement, which is a function of developmental stage, population density, and weather (Narisu et al., 1999, 2000), as well as the properties of the insecticide (insecticides with longer residuals allow wider spacing between treated swaths). Foster et al. (2000) left 20 to 50% of their study plots untreated, while Lockwood et al. (2000) left 20 to 67% of their treatment areas untreated. Currently the grasshopper program typically leaves 50% of a spray block untreated for ground applications where the swath width is between 20 and 45 feet. For aerial applications, the skipped swath width is typically no more than 20 feet for malathion, 100 feet for carbaryl and 200 feet for diflubenzuron. The selection of insecticide and the use of an associated swath widths is site dependent.

Reduced rates should prove beneficial for the environment. All APHIS grasshopper treatments using carbaryl, diflubenzuron, or malathion are conducted in adherence with USEPA-approved label directions. Labeled application rates for grasshopper control tend to be lower than rates used against other pests. In addition, use rates proposed for grasshopper control by APHIS (see table 3–1) are lower than rates used by private landowners. APHIS maximum RAAT rates assume 100 percent coverage at a reduced application rate, while the average RAAT rates reflect a more realistic scenario in which rates and coverage are reduced.

Table 3–1. Alternative 1 Labeled Rates (lb. ai./acre) for Grasshopper Control

	Maximum Labeled Grasshopper Rate	APHIS Full Rate	APHIS Maximum RAATs Rate	APHIS Average RAATs Rate
Carbaryl Spray	1.5	0.5	0.25	0.1875
Diflubenzuron	0.031	0.016	0.012	0.006
Malathion	0.928	0.619	0.309	0.248

Additional Treatment Requirements

APHIS grasshopper treatments must follow all applicable Federal, State, tribal, and local laws and regulations regarding pesticide use, including all USEPA- and State-approved label instructions. APHIS has also implemented several measures that go beyond label instructions in order to protect workers and the environment. These measures must be followed when applying insecticide treatments. The measures are to assure that a treatment is efficacious, economical, and conducted to ensure the safety of workers and the environment.

All aircraft must have a positive on/off system that will prevent leaks from the nozzles and a positive emergency shutoff valve between the tank and the pump. Whenever possible, applicators must avoid aerial ferrying and turnaround routes over water bodies and sensitive habitats (USDA APHIS, 2013). This will reduce the risk of accidental release of insecticides into aquatic habitats and other sensitive habitats.

Operational procedures are also in place to assure, as much as possible, that insecticide application would be limited to the treatment area. In the use of reduced rates, the accurate placement of the insecticide is essential if grasshopper populations are to be suppressed efficaciously. Weather plays an important role in aerial application. Winds may displace the insecticide, and high air temperatures combined with low humidity may cause fine droplets to evaporate and drift without reaching the target. During applications, APHIS personnel constantly monitor wind conditions, as well as ground and air temperatures. Should wind speed in the treatment area exceed 10 mph, or a change in wind direction towards sensitive habitat is noted, or should a temperature inversion (characterized by stable air with little mixing that can result in off-site transport of drift once wind speeds increase) be detected, spray programs end until conditions are again favorable.

The Program has also established treatment restriction buffers around water bodies to protect those features from insecticide drift and runoff. The labels for all Program uses of the insecticides prohibit direct application to water (defined as reservoirs, lakes, ponds, pools left by seasonal streams, springs, wetlands, and perennial streams and rivers). APHIS maintains the following additional buffers for water bodies that are not designated critical habitat for listed aquatic species: 500-foot buffer for aerial sprays, 200-foot buffer for ground sprays, and a 50-foot buffer for bait applications (USDA APHIS, 2013). These buffers are designed to reduce pesticide transport to aquatic habitats via runoff and drift.

Potential Impacts of Insecticide Applications

To understand the potential impacts of the various treatment alternatives, it is important to understand the persistence of the chemicals in various environments and how the insecticides might degrade in the environment. Often, degradation will lead to more benign substances in the environment; however, residues and various chemical degradates may still remain.

The below discussion on potential impacts often refers to the half-life of the insecticide. The half-life indicates the potential for the insecticide to accumulate in the environment. Insecticides with short half-lives (e.g., 16 days) tend to build up less because they are much less likely to persist in the environment. Insecticides with long half-lives (e.g., 120 days) are more likely to accumulate if there are repeated applications and may cause increased risks of contaminating surface and ground water, plants, and animals.

a. Carbaryl

Carbaryl is a member of the N-methyl carbamate class of insecticides, which affect the nervous system via cholinesterase inhibition. Inhibiting the enzyme acetylcholinesterase (AChE) causes nervous system signals to persist longer than normal. While these effects are desired in controlling insects, they can have undesirable impacts to non-target organisms that are exposed.

Carbaryl is registered for use in agriculture to control pests, including moths, beetles, cockroaches, ants, ticks, and mosquitoes, on terrestrial food crops, cut flowers, nursery and ornamentals, turf, greenhouses, golf courses, and in oyster beds. Carbaryl is also registered for use on residential shrubs, gardens, ornamentals, and turfgrass (USEPA, 2000b, 2008a). The Program currently uses Sevin® XLR Plus spray, which contains 44% carbaryl, as well as various carbaryl baits (i.e., Sevin® 5 Bait, 2% Sevin® Bait, and Drexel Carbaryl 2% Bait Granular). The products used in the Program may change based on USEPA and state registrations as well as product availability.

Physical Environment

Air

It is unlikely that carbaryl will significantly vaporize from the soil, water, or treated surfaces (Dobroski et al., 1985). Carbaryl may be found in the atmosphere within air-borne particulates or as spray drift and can react with hydroxyl radicals in the ambient atmosphere (Kao, 1994). Once in the air, carbaryl has a half-life of 1 to 4 months.

Water

Temperature, pH, light, oxygen, and the presence of microorganisms and organic material are factors that contribute to how quickly carbaryl will degrade in water. Carbaryl will degrade to 1-naphthol, methylamine and carbon dioxide (CO_2) (Aly and El-Dib, 1971; Larkin and Day, 1986). Hydrolysis, the breaking of a chemical bond with water, is the primary degradation pathway for carbaryl at pH 7 and above. The compound degrades rapidly at pH 7 and 9 at 25 °C, with half-lives of approximately 10 to 17 hours and 3 hours, respectively (Aly and El-Dib, 1971; USEPA, 2003a). Studies to support the registration of carbaryl in the United States show a similar effect of pH on hydrolysis rates with a half-life of 12 days at a pH of 7 and 3.2 hours at a pH of 9 (USEPA, 2003b). Carbaryl is assumed to be hydrolytically stable at a pH of 5 (USEPA, 2003b).

In natural water, carbaryl is expected to degrade faster than in laboratory settings due to the presence of microorganisms. The half-lives of carbaryl in streams, rivers, and brooks, as a result of forest spraying, are 25, 28, and 23 hours, respectively (Stanley and Trial, 1980). Bonderenko et al. (2004) reported aqueous half-lives of carbaryl in natural waters from California and Washington State ranging from 0.3 to 4.7 days. Degradation in the study was temperature dependent with shorter half-lives at higher temperatures. Armbrust and Cosby (1991) reported hydrolysis half-lives of carbaryl in filtered and sterilized seawater at pH 7.9 and 8.2 at 24 ºC as 24 and 23 hours, respectively, and the major degradation product was 1-naphthol. Naphthol was not degraded in sterile seawater stored in the dark, but was undetected within 96 hours in raw seawater. When exposed to artificial sunlight, carbaryl had a half-life of 5 hours and naphthol was completely degraded in 2 hours. Carbaryl has a reported solubility range of 23 to 120 mg/L suggesting moderate solubility (USEPA, 2003b; USDA FS, 2008a). The range of solubility values reported for carbaryl is due to the variability in test conditions during each study. Standardized solubility measurements under USEPA guideline studies report a solubility of 32 mg/L

The aqueous photolysis, the decomposition of chemicals in water by light, of carbaryl was determined to be 21 days in sterile distilled water under artificial sunlight at a concentration of 10.1 ppm and pH 5 (Das, 1997). The intensity of artificial light was comparable to that of natural sunlight, at 510.5 and 548.8 watts/square meter (m^2), respectively. Other reported aqueous photolysis half-lives are much shorter than that obtained from sterile water. Wolfe et al. (1978) reported a photolysis half-life for carbaryl as 6.6 days, and Zepp et al. (1976) as 50 hours near the water surface. The aqueous photolysis rates increase as intensity of sunlight increases; therefore, the rate of photolysis is much faster in summer than in winter. Wolfe et al. (1976) calculated aqueous photolysis half-lives of carbaryl in surface water (in <10 cm water) at latitude 40 degrees North in different seasons—64 hours in spring, 52 hours in summer, 102 hours in fall, and 200 hours in winter. The major photolysis product is 1-naphthol, which will further photooxidize rapidly to 2-hydroxyl-1,4-naphtho-quinone in basic conditions (Wauchope and Haque, 1973). Suspended particulates in natural water may remove some carbaryl from the aqueous phase. Karinen et al. (1967) reported that 50% of initial carbaryl dissipated from estuarine water after 38 days at 8º C in the absence of mud; in the presence of mud, 90% of initial applied carbaryl was withdrawn from the water after 10 days at the same temperature due to significant removal of carbaryl by sediment.

Microbial degradation under oxic (oxygen is present) conditions in combination with other degradation pathways results in a relatively short half-life for carbaryl in water. Aerobic aquatic metabolism is much quicker with a reported half-life range of 4.9 to 8.3 days compared to anaerobic (without oxygen) aquatic metabolism range of 15.3 to 72 days (Thomson and Strachan, 1981; USEPA, 2003a).

Soil

Overall, carbaryl is not persistent in soil due to multiple degradation pathways including hydrolysis, photolysis, and microbial metabolism. Microbes play a significant role in the degradation of carbaryl in soil (Xu, 2003). Chapalamadugu and Chaudhry (1991) revealed that two *Pseudomonas* species, soil bacteria, can metabolize carbaryl or its primary metabolite, 1-naphthol to CO_2 within 36 hours.

In aerobic soil, carbaryl quickly degrades with half-lives ranging from approximately 4 to 95 days (Miller, 1993). A significant amount of CO_2 from carbaryl degradation was produced, ranging from 0.1% at day 1 to 59.7% at day 14. Carbaryl degrades more slowly in anaerobic aquatic soil, with an estimated half-life of 72 days (Miller, 1993). 1-naphthol is the major degradate with minor compounds of 1,4-naphthoquinone, 5-hydroxy-1-naphthyl methylcarbamate and 1-naphthyl-(hydroxymethyl) carbamate. The degradate 1-naphthol may represent up to 67% of applied carbaryl. None of the minor degradates account for more than 2.5% of the total applied dose. Degradation of 1-naphthol in soil is rapid, with levels below detection after 14 days (USEPA, 2003a). Carbaryl in soil is resistant to photolysis based on available data.

The adsorption coefficient values (K_{oc}, the measure of movement of a substance through soil; the higher the value, the stronger the adsorption, the less likely a substance will move through the soil) of carbaryl range from 100 to 1,054 (Jana and Das, 1997; USEPA, 2003a; USDA FS, 2008a), indicating carbaryl moderately binds to soil. Carbaryl sorption to soil has been shown to increase with increasing percent organic carbon (Shareef and Shaw, 2008). Sorption experiments using two types of soils, Red Bay (AB) and Astatula (AS), were further separated into two layers—topsoil (0–30 cm) and subsoil (31–60 cm) (Nkedi-Kizza and Brown, 1998). The properties of individual soil are AB top (pH 6.3), AB sub (pH 5.3), AS top (pH 5.6) and AS sub (pH 4.8). The K_{oc} of carbaryl in soils were 338, 144, 590, and 671 mg/kg on AB topsoil, AB subsoil, AS topsoil, and AS subsoil, respectively. The half-lives of carbaryl on the four soils ranged from 8 to 18 days. Given the same soil, carbaryl degraded much faster in topsoil than in subsoil.

Terrestrial field dissipation studies were conducted at two locations, one in California and one in North Carolina (Norris, 1991). Data showed that most residues remain in the first 0–0.15 meters (m) of soil, with only one finding in the layer of 0.3–0.45 m. The dissipation half-lives of carbaryl were estimated to be from 0.76 to 10.9 days. In a forestry dissipation study, half-lives ranged from 21 days on foliage to 75 days in leaf litter (USDA FS, 2008).

Carbaryl bait, due to its application method, will exhibit reduced soil effects when compared to spray applications (USDA APHIS, 1987). Little transport of carbaryl through runoff or leaching to groundwater is expected due to the low water solubility, moderate sorption, and rapid degradation in soils. There are no reports of carbaryl detection in groundwater, and less than 1% of granule carbaryl applied to a sloping plot was detected in runoff (Caro et al., 1974).

Vegetation

Carbaryl, at all Program rates, is expected to pose minimal risk to aquatic and terrestrial plants. Carbaryl has a short residual half-life on plant surfaces. USEPA reports a foliar dissipation half-life of 3.71 days (USEPA, 2010) (USEPA, 2010). Insecticidal properties are retained for 3 to 10 days (USEPA, 1985). The major metabolite is 1-naphthol. Bioconcentration of carbaryl in plants is not of concern due to limited plant uptake related to low water solubility and rapid degradation (Nash, 1974). Based on forestry field dissipation studies, foliar half-lives of 21 days have been reported with a leaf litter half-life of 75 days (USEPA, 2003a).

Toxicity to terrestrial plants has been evaluated for several agronomic crops using the formulation of Sevin® XLR Plus. Typically, USEPA's Office of Pesticide Programs (OPP) requires terrestrial phytoxicity testing using the formulated material. The plants tested that showed no effects at a rate of 0.803 pound (lb) active ingredient (a.i.)/ acre (ac) were cabbage, cucumber, onion, ryegrass, soybean, and tomato (USEPA, 2003a). The application rate used in these studies is above the rates (0.50 lb a.i./ac full coverage, 0.25 lb a.i./ac RAATs) that are projected for carbaryl use in the APHIS' Program. Several terrestrial plant incident reports have been filed with USEPA under FIFRA Section 6(a)2; however, for a majority of the cases, the doses used were well above those proposed in the Program and involved potential misuse in home lawn applications (USDA APHIS, 2015).

USEPA-registered carbaryl spray label, Sevin® XLR Plus, indicates application of the insecticide to wet foliage or during periods of high humidity may cause injury to tender foliage. The product label indicates not to use the insecticide on Boston ivy, Virginia creeper, maidenhair ferns, and Virginia and sand pines because these plants may be injured (USEPA, 2012d). Bait labels (i.e., Sevin® 5 Bait, 2% Sevin® Bait, and Drexel Carbaryl 2% Bait Granular) do not carry similar warnings (USEPA, 2012a, 2014b, a).

Under alternative 1, carbaryl treatments should greatly reduce grasshopper populations and subsequent damage to rangeland vegetation, surrounding crops, and other vegetation. Plants may be impacted if carbaryl decreases populations of terrestrial invertebrate pollinators. In addition, plants that depend on certain animals for seed dispersal may be impacted from carbaryl applications. Potential impacts to pollinators and wildlife are discussed below.

Livestock and Other Grazing Animals

USEPA regulates the amount of pesticide residues that can remain in or on food or feed commodities as the result of a pesticide application. The agency does this by setting a tolerance, which is the maximum residue level of a pesticide, usually measured in parts per million (ppm), that can legally be present in food or feed. USEPA-registered carbaryl products used by the grasshopper program are labeled with rates and treatment intervals that are meant to protect livestock and keep chemical residues in cattle at acceptable levels (thereby protecting human health). Tolerances are set for the amount of carbaryl that is allowed on grass (100 ppm) and various forage, fodder, straw and hay (e.g., alfalfa hay, 100 ppm; barley, green fodder, 100 ppm; birdsfoot trefoil, forage, 100 ppm) as well as for carbaryl residues in cattle (cattle fat (0.1 ppm), meat (0.1 ppm), and meat byproducts (0.1 ppm)) (40 CFR Parts 180.169).

While livestock and horses may graze on rangeland the same day that the land is sprayed, in order to keep tolerances to acceptable levels, carbaryl spray applications on rangeland are limited to 1 quart per acre per year (USEPA, 2012d). Applications of baits are limited to a retreatment interval of 14 days, no more than 2 applications per year, and no applications within either 7 or 14 days of grazing, depending on the product (USEPA, 2012a, 2014b, a). The grasshopper program would treat at or below use rates that appear on the label, as well as follow all appropriate label mitigations, which would ensure residues are at the appropriate levels.

<u>Wildlife</u>

USDA APHIS (2018a) assessed available laboratory studies regarding the toxicity of carbaryl on fish and wildlife. In summary, the document indicates the chemical is highly toxic to insects, including native bees, honeybees, and aquatic insects; slightly to highly toxic to fish; highly to very highly toxic to most aquatic crustaceans, moderately toxic to mammals, minimally toxic to birds; moderately to highly toxic to several terrestrial arthropod predators; and slightly to highly toxic to larval amphibians.

The USEPA-approved use rates and patterns and the additional mitigations imposed by the grasshopper program, such as using RAATs and application buffers, where applicable, further minimize exposure and risk.

Mammals

Acute and chronic risks to mammals are expected to be low to moderate based on the available toxicity data and conservative assumptions that were used to evaluate risk. There is the potential for impacts to small mammal populations that rely on terrestrial invertebrates for food. Weiland et al. (2002) assessed the impacts of Sevin® XLR Plus applications at 750 grams (g) active ingredient (a.i.)/ hectare (ha) to several invertebrate groups over a 21-day period. This rate equates to 0.67 lb a.i./ac which is 1.34 times higher than the highest rate allowed in the Program. Results from the study demonstrated no negative effects on abundance in the following insect groups: Homoptera, Hymenoptera, Coleoptera, Hemiptera, Lepidoptera, or Neuroptera. For additional information on the impacts on small mammals' diet, see section on terrestrial invertebrates below.

Indirect risks to mammals are primarily impacts to habitat or prey. Loss of habitat can occur through carbaryl-related effects to terrestrial plants. Based on the available terrestrial phytotoxicity data, no effects at rates as high as 0.803 lb a.i./ac have been observed in several agronomic crops. There have been reported cases of terrestrial phytotoxicity, mostly in urban applications, but these rates are much higher than full application rates of 0.50 lb a.i./ac that are used in the Program. Based on the lack of known effects at the highest Program rates for ULV and bait applications of carbaryl, indirect risk to mammalian habitat is expected to be minimal. Additionally, based on the toxicity data for terrestrial plants, minimal risks of indirect effects are expected to mammals that rely on plant material for food. Carbaryl has a reported half-life on vegetation of 3 to 10 days, suggesting mammal exposure would be short-term. Mammal exposure in various studies assumes exclusive consumption of contaminated short grass throughout, which is unlikely. Lastly, direct risks to mammals from carbaryl bait applications is expected to be minimal based on oral, dermal, and inhalation studies (USDA APHIS, 2018a).

Birds

A number of studies have reported no effects on bird populations in areas treated with carbaryl (Buckner et al., 1973; Richmond et al., 1979; McEwen et al., 1996). Some applications of formulated carbaryl were found to cause depressed AChE (enzymes involved in nerve impulses) levels (Zinkl et al., 1977; Gramlich, 1979); however, the doses were twice those proposed for the full coverage application in the grasshopper program. AChE inhibition at 40 to 60% affects coordination, behavior, and foraging ability in vertebrates. This could lead to death from weather, predators, or other stresses of survival in the wild. Studies over several years for multiple grasshopper treatment areas have shown AChE inhibition at levels of no more than 40% with most at less than 20% (McEwen et al., 1996).

The use of Sevin® 4-Oil, at the formulation rate of 1.25 lbs a.i./acre, has demonstrated no toxicity-caused mortality of birds, and none has been observed as part of the grasshopper IPM monitoring effort (McEwen et al., 1996). Field studies in North Dakota were conducted to determine the effects of Sevin® 4-Oil treatment on killdeer populations. At treatment rates of 0.5 and 0.4 lb a.i./acre, no toxic signs and no mortality were observed. Effects on foraging and diet of the killdeer were examined by both direct observation and analysis of stomach contents (Fair et al., 1995a). The insect capture rate by foraging killdeer increased during the 2-day period after treatment when affected insects were easily obtainable (Fair et al., 1995b). There were no other differences or changes in food habits observed.

As part of the grasshopper IPM monitoring studies, a test was conducted in North Dakota to observe the effect of carbaryl bait on the nestling growth and survival of vesper sparrow (Adams et al., 1994). This study was designed to simulate the treatment of a small grasshopper infestation with carbaryl bait. There was no difference reported in any of the productivity parameters between nests on treated and untreated sites (Adams et al., 1994). Adult sparrows on treated sites had to forage farther from the nests to obtain food but did so successfully (McEwen et al., 1996).

Amphibians and Reptiles

A field study was conducted using Woodhouse's toad (*Bufo woodhousii*) and gray treefrog (*Hyla versicolor*) in exposures to 3.5 and 7.0 mg/L of Sevin® formulation (Boone and Semlitsch, 2001). Mass at metamorphosis, days to metamorphosis, and survival to metamorphosis were measured in outdoor exposures with effects on survival in both species seen at the highest test concentration (7 mg/L). No effect on mass at metamorphosis was observed at any dose in the Woodhouse's toad exposures, but an effect was seen at the highest dose in the gray treefrog exposure. Both species had statistically significant effects on days to metamorphosis when compared to controls at the highest test concentration. Any potential impacts to amphibians would need to be assessed at the time that treatment is being considered. Green frog (*Rana clamitans*) metamorphs and tadpoles were also assessed and no statistically significant effects or interactions were observed at either test concentration.

Indirect effects to amphibians can include loss of habitat and food items. From a habitat perspective, this can include carbaryl effects to terrestrial and aquatic plants. Carbaryl, at all Program rates, is expected to pose minimal risk to aquatic and terrestrial plants. The other area of indirect risk is the loss of food items, which can include aquatic plants and invertebrates; minimal indirect risk to amphibian food items is anticipated.

Due to the lack of data, assessing risk to reptiles is not possible. Currently USEPA-OPP assumes that the range of sensitivities for avian species represents reptiles; however, there is large uncertainty in making that type of extrapolation. In the absence of data however, making that assumption provides some insight regarding potential direct and indirect risk to reptiles from carbaryl applications. Based on the risk characterization for avian species using residues from the most conservative application method, all potential carbaryl applications would have minimal direct and indirect risks when the proposed application buffers are considered.

Fish and Aquatic Invertebrates

Several field studies that assist in determining impacts of carbaryl on aquatic invertebrates and fish have been published (Relyea and Diecks, 2008; USDA FS, 2008a; NMFS, 2009) and are summarized below. The value of these studies is limited because they all had dosing levels or frequencies that are much higher than would occur in the grasshopper program.

In a field study related to the grasshopper control program, applications of carbaryl were made in proximity to the Little Missouri River over a two-year period and impacts to fish and aquatic invertebrates assessed (Beyers et al., 1995). Measured carbaryl concentrations were 85.1 parts per billion (ppb) in a drought year and 12.0 ppb in a non-drought year 1 hour after application. Brain cholinesterase, an enzyme that allows for the proper functioning of the nervous system, was measured in the fathead chub (*Platygobio gracilis*) in a drought and non-drought year after applications of Sevin®-4-Oil for the control of rangeland grasshoppers. No effects were seen on brain cholinesterase activity for either season when compared to chubs from the reference site. Invertebrate sampling resulted in an increase in the coefficient of variation in invertebrate drift 3 hours after treatment at a measured concentration of 12.3 micrograms (µg)/L 4 hours post-treatment. The increase in variability was not observed after that sampling event, and concentrations of carbaryl decreased to 0.100 µg/L 96 hours post-treatment. No impacts in invertebrate drift were noted in the second year of application where carbaryl concentrations of 12.6 µg/L were measured 2 hours post-treatment. Drift in this case is defined as stream invertebrates that leave their substrate and move downstream. Residues measured in this study are not based on current methods of carbaryl applications and do not incorporate current rates and Program application restrictions.

Courtemanch and Gibbs (1980) reported similar impacts on invertebrate drift in field studies after direct application of Sevin-4-Oil® to streams. Residues were not measured; however, correlations to other studies in the manuscript suggest aquatic residues of 26 to 42 µg/L caused the increase in drift, which is well above residues predicted from Program applications. In another field study that assessed brain cholinesterase levels after carbaryl treatment, Haines (1981) noted a depression in brook trout (*Salvelinus fontinalis*) cholinesterase activity when Sevin-4-Oil® was applied at 1 lb a.i./ac in a forestry application in Maine. Similar results have been seen in other field studies, with brook trout AChE depression following 1 lb/acre treatments. Due to the rapid reversibility associated with carbaryl, AChE levels returned to normal within 48 hours (Hurlbert, 1978). In another field study, a split application of Sevin® 2-Oil at 280 g/ha for each application was used to evaluate impacts to brook trout and slimy sculpin (*Cottus cognatus*) as well as aquatic invertebrates (Holmes et al., 1981). Maximum measured residues were 313.7 and 122.6 µg/L after each application and declined to less than 1 µg/L after 10 days. Invertebrate drift was impacted; however, overall impacts to aquatic invertebrates were reported as negligible and stomach contents from both fish species demonstrated that there was no reduction in food availability.

The effects measured in the above studies are difficult to extrapolate and apply to conditions in the current Program. While sublethal effects have been noted in fish with depressed AChE, as well as some impacts to invertebrates in the field due to carbaryl, the application rates and measured aquatic residues where it was observed in these studies are well above values that would be expected from current Program operations. Indirect risks to fish species can occur through the loss of habitat or reduction in prey, yet data suggests that carbaryl risk to aquatic plants that may serve as habitat, or food, for fish and aquatic invertebrates is very low.

Product use restrictions appear on the USEPA-approved label and attempt to keep carbaryl out of waterways. Carbaryl must not be applied directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark (USEPA, 2012d).

Terrestrial Invertebrates

Carbaryl applications have the potential to affect the nervous system via cholinesterase inhibition in various sensitive beneficial invertebrates. The preferred use of RAATs in the Program and use of carbaryl bait applications reduces this risk.

Smith et al. (2006) assessed changes in non-target arthropod populations following applications of carbaryl, diflubenzuron, or malathion using RAATs. In the 2-year study, post application surveys of the major insect fauna revealed that only ants were affected negatively by grasshopper applications within treatment areas. As stated previously, Weiland et al. (2002) assessed the impacts of Sevin® XLR Plus applications at 750 grams (g) a.i./ha to several invertebrate groups over a 21-day period. This rate equates to 0.67 lb a.i./ac which is 1.34 times higher than the highest rate allowed in the Program. Results from the study demonstrated no negative effects on abundance in the following insect groups: Homoptera, Hymenoptera, Coleoptera, Hemiptera, Lepidoptera, and Neuroptera.

Pollinators

The majority of rangeland plants require insect-mediated pollination. Native, solitary bee species are important pollinators on western rangeland (Tepedino, 1979). Potential negative effects of insecticides on pollinators are of concern because a decrease in their numbers has been associated with a decline in fruit and seed production of plants. Rangeland species populations that depend on plants for food may be indirectly affected due to changes in vegetation patterns (Alston and Tepedino, 1996).

Laboratory studies have indicated that bees are sensitive to carbaryl applications but the studies were at rates above those proposed in the Program. The reduced rates of carbaryl used in the Program and the implementation of application buffers should significantly reduce exposure of carbaryl applications to pollinators. In areas of direct application where impacts may occur, alternating swaths and/or reduced rates (i.e., RAATs) would reduce risk. Limited field data is available that discusses carbaryl effects to honeybees. Based on a field study using Carbaryl SC (soluble concentrate) at a rate of 0.80 lb a.i./ac in a fruit orchard, there were no effects on bee mortality or behavior 7 days post-application (USEPA, 2003a). Potential negative effects of grasshopper program insecticides on bee populations may also be mitigated by the use of carbaryl bran baits. Studies with carbaryl bran bait have found no sublethal effects on adults or larvae (Peach et al., 1994, 1995).

Product use restrictions and suggestions to protect bees appear on USEPA-approved product labels and are followed by the grasshopper program. Mitigations such as not applying to rangeland when plants visited by bees are in bloom, notifying beekeepers within 1 mile of treatment areas at least 48 hours before product is applied, limiting application times to within 2 hours of sunrise or sunset when bees are least active, appear on product labels such as Sevin® XLR Plus (USEPA, 2012d). Similar use restrictions and recommendations do not appear on bait labels because risks to bees are reduced. APHIS would adhere to any applicable mitigations that appear on product labels.

Human Health

Human studies, including clinical and epidemiological studies, provide direct evidence of human health effects resulting from a stressor. However, clinical studies on humans are often not available due to significant ethical concerns associated with the human testing of environmental hazards. Generally, epidemiological human studies do not include accurate exposure information, and it is difficult to separate the effects of multiple stressors. Animal toxicity studies, such as those using rats, mice, rabbits, etc. allow inferences about the potential hazard to humans when human studies are unavailable. Animal studies can be designed, controlled, and conducted to address specific toxicity data gaps. However, extrapolating results from animal subject to humans presents uncertainties that influence use of the results (USEPA, 2017b).

USEPA requires the submission of certain toxicity data during the pesticide registration process in order to address direct and indirect exposures to humans. The agency prefers the use of rats, rabbits, or guinea pigs in certain toxicity testing. Therefore, this type of data is usually readily available and will be used and cited below to support discussions regarding potential human health impacts. Indirect human health concerns are also supported by environmental toxicity studies.

Adverse human health effects from the proposed Program ULV applications of the carbaryl spray (Sevin® XLR Plus) and bait applications of the carbaryl 5% and 2% baits formulations to control grasshoppers are not expected based on low potential for human exposure to carbaryl and the environment and favorable environmental fate and effects data. Technical grade (approximately 100% of the insecticide product is composed of the active ingredient) carbaryl exhibits moderate acute oral toxicity in rats, low acute dermal toxicity in rabbits, and very low acute inhalation toxicity in rats. Technical carbaryl is not a primary eye or skin irritant in rabbits and is not a dermal sensitization in guinea pig (USEPA, 2007). This data can be extrapolated and applied to humans.

Carbaryl can cause cholinesterase inhibition (i.e., overstimulate the nervous system) in humans resulting in nausea, headaches, dizziness, anxiety, and mental confusion, as well as convulsions, coma, and respiratory depression at high levels of exposure (NIH, 2009; Beauvais, 2014). USEPA classifies carbaryl as "likely to be carcinogenic to humans" based on vascular tumors in mice (USEPA, 2007, 2015a, 2017d).

The Sevin® XLR Plus formulation, which contains a lower percent of the active ingredient than the technical grade formulation, is less toxic via the oral route, but is a mild irritant to eyes and skin. The proposed use of carbaryl as a ULV spray or a bait, use of RAATs, and adherence to label requirements, substantially reduces the potential for exposure to humans. The most likely exposed human populations are Program workers and the general public. APHIS does not expect adverse health risks to workers based on low potential for exposure to carbaryl when applied according to label directions and use of personal protective equipment (PPE) (e.g., long-sleeved shirt and long pants, shoes plus socks, chemical-resistant gloves, and chemical-resistant apron) (USEPA, 2012d) during loading and applications. APHIS quantified the potential health risks associated with accidental worker exposure of carbaryl during mixing, loading, and applications. The quantitative risk evaluation results indicate no concerns for adverse health risk for Program workers (http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 16, 2019)).

Adverse health risk to the general public from carbaryl exposure in treatment areas from ground or aerial applications is not expected due to the low potential for exposure (such as low population density in the treatment areas, and adherence to label requirements and Program measures designed to reduce exposure to the public). APHIS treatments are conducted in rural rangeland areas consisting of widely scattered, single, rural dwellings in ranching communities, where agriculture is a primary industry. Label requirements to reduce exposure include proper storage and disposal of the chemical, appropriate water buffers, limiting spray drift, and human re-entry restrictions. Program mitigation measures, such as applying carbaryl only once per season, and the use of lower application rates and RAATs are discussed in section titled "Potential Impacts of Program Treatment Techniques and Strategies". Program measures beyond those on the label require application buffers from structures as well as aquatic areas reducing the potential for exposure to the public from direct exposure due to drift and from drinking water sources. Detailed discussions on the evaluation of potential human health risks are available at: http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 16, 2019).

b. Diflubenzuron

Diflubenzuron is a restricted use pesticide (only certified applicators or persons under their direct supervision may make applications) registered with USEPA as an insect growth regulator. It specifically interferes with chitin synthesis, the formation of the insect's exoskeleton. Larvae of affected insects are unable to molt properly. While this effect is desirable in controlling certain insects, it can have undesirable impacts to non-target organisms that are exposed.

The insecticide is registered for use on several food/feed crops, ornamentals, wide-area general outdoor treatments, standing water and sewage systems, and forest lands against many leaf-eating insect larvae that feed on agricultural, forest and ornamental plants, mosquito larvae, aquatic midges, rust mites, boll weevils, and flies (USEPA, 1997). The grasshopper program uses the diflubenzuron spray product Dimilin® 2L.

USEPA considers diflubenzuron relatively non-persistent and immobile under normal use conditions and stable to hydrolysis and photolysis. The chemical is considered unlikely to contaminate ground water or surface water (USEPA, 1997). Specific environmental fate studies are discussed below.

<u>Physical Environment</u>

Air

The vapor pressure of diflubenzuron is relatively low (0.00012 mPa) suggesting the chemical will not volatilize readily into the atmosphere from soil or plants. Volatilization from water is also not expected using the reported low Henry's Law Constant value (1.8 X 10^{-9} atm*m^3/mol) which measures the tendency of chemicals to move from solution into the atmosphere (Wauchope et al., 1992; USEPA, 1997). Based on the low application rate and fate characteristics for diflubenzuron, exposure from volatilization is expected to be minimal.

Water

Diflubenzuron is stable to hydrolysis at pH values of 5 and 7, with a reported hydrolysis half-life at pH 9 of 32 days (Ivie et al., 1980; USEPA, 1997).

Degradation half-lives in the presence of oxygen are slightly shorter ($T_{½}$ = 0.42 days) compared to degradation in the absence of oxygen ($T_{½}$ = 0.97 days) (Anton et al., 1993). Due to its low solubility (0.2 mg/L) and preferential binding to organic matter, diflubenzuron seldom persists more than a few days in water (Schaefer and Dupras, 1977; Schaefer et al., 1980). Persistence in water is typically short with a dissipation half-life of 3.3 to 8.2 days, based on field studies in littoral enclosures (Knuth and Heinis, 1995; Boyle et al., 1996). Half-life values in sediment were similar to those in water, with reported half-life values ranging from 6.2 to 10.4 days. Aerobic aquatic half-life data in water and sediment was reported as 26.0 days (USEPA, 1997). Sundaram et al. (1991) reported maximum dissipation half-lives (DT_{50} and DT_{90}) values of 1.3 and 4.2 days, respectively, in pond water and 0.2 and 1.0 day in streams. Under anaerobic conditions, the metabolic half-life for diflubenzuron is reported as 34 days (USEPA, 1997).

Soil

Mobility and leachability of diflubenzuron in soils is low, and residues are usually not detectable after 7 days (Eisler, 2000). Diflubenzuron has been shown to bind readily with organic matter in soils, and is relatively immobile in the environment (USEPA, 1997). Adsorption values vary depending on soil type (40, 40, 20, 25, 130, 110, 150, and 3,500 for a sand clay, silty clay loam, silt loam, sand loam, sand clay loam, clay, a clay hydrosol, and a peat hydrosoil, respectively) and indicate preferential adsorption to soil over remaining in solution due to low solubility (Sundaram et al., 1997; USEPA, 1997). Soil adsorption coefficients ranging from 8,700 to 10,000 have also been reported in the literature (USDA FS, 2004).

The persistence of diflubenzuron in soils is microbe dependent where degradation occurs more rapidly in the presence of microbes. The half-life of diflubenzuron under field conditions ranges from 7 days to about 19 days (Nigg et al., 1986). In standardized laboratory studies where diflubenzuron was marked with a radiolabel, aerobic soil metabolism ranged from 2 to 14 days. The major metabolite was 4-chlorophenyl urea which composed approximately one-third of the radiolabel 7 to 14 days after treatment. The other major metabolite was CO_2, along with three other metabolites (2,6-difluorobenoic acid, 2,6-difluorobenzamide, 4-chloroaniline) that consisted of less than 10% of the radiolabeled material. The same half-life range was observed in the anaerobic soil metabolism study with the same approximate distribution of metabolites (USEPA, 1997). Field dissipation studies, in general, support the laboratory half-life of diflubenzuron with orchard and bare ground dissipation half-lives of 5.8 to 13.2 days. However, field dissipation studies in California citrus and Oregon apple orchards reported half-live values of 68.2 to 78 days.

Vegetation

Diflubenzuron applied to foliage remains adsorbed to leaf surfaces for several weeks with little or no absorption or translocation from plant surfaces (Eisler, 1992, 2000).

Diflubenzuron treatments are expected to have minimal effects on terrestrial plants. Both laboratory and field studies demonstrate no effects using diflubenzuron over a range of application rates, and the direct risk to terrestrial plants is expected to be minimal (USDA APHIS, 2018c).

Diflubenzuron should greatly reduce grasshopper populations and subsequent damage to rangeland vegetation, surrounding crops, and other vegetation. Plants may be impacted if diflubenzuron decreases populations of terrestrial invertebrate pollinators. The potential risks to pollinators are discussed below in the section on terrestrial invertebrates. In addition, plants that depend on certain animals for seed dispersal may be impacted from diflubenzuron applications. Potential impacts to wildlife are discussed below.

Livestock and Other Grazing Animals

Dimilin® 2L is labeled with rates and treatment intervals that are meant to protect livestock and keep residues in cattle at acceptable levels (thereby, protecting human health). While livestock and horses may graze on rangeland the same day that the land is treated with diflubenzuron, the label limits applications on rangeland to no more than 1.5 ounces of active ingredient per acre per calendar year (USEPA, 2017c). Tolerances are set for the amount of diflubenzuron that is allowed in cattle fat (0.05 ppm) and meat (0.05 ppm) (40 CFR Parts 180.377). The grasshopper program would treat at application rates indicated on product labels or lower, which should ensure approved residues levels.

Wildlife

APHIS' literature review found that on an acute basis, diflubenzuron is considered toxic to some aquatic invertebrates and practically non-toxic to adult honeybees. However, diflubenzuron is toxic to larval honeybees (USEPA, 2018). It is slightly nontoxic to practically nontoxic to fish and birds and has very slight acute oral toxicity to mammals, with the most sensitive endpoint from exposure being the occurrence of methemoglobinemia (a condition that impairs the ability of the blood to carry oxygen). Minimal direct risk to amphibians and reptiles is expected, although there is some uncertainty due to lack of information (USDA APHIS, 2018c; USEPA, 2018).

Risk is low for most non-target species based on laboratory toxicity data, USEPA approved use rates and patterns, and additional mitigations such as the use of lower rates and RAATs that further reduces risk. Risk is greatest for sensitive terrestrial and aquatic invertebrates that may be exposed to diflubenzuron residues. Additional field collected data regarding effects to fish and wildlife are discussed below.

Mammals

In a review of mammalian field studies, Dimilin® applications at a rate of 60 to 280 g a.i./ha had no effects on the abundance and reproduction in voles, field mice, and shrews (USDA FS, 2004). These rates are approximately 3 to 16 times greater than the highest application rate proposed in the Program. Seidel and Whitmore (1995) documented no effects on white-footed mice (*Peromyscus leucopus*) densities in untreated and treated areas with 140 g a.i./ha diflubenzuron. Mice on treated plots consumed fewer lepidopterans (order of insects that includes butterflies and moths) larvae compared to controls; however, the total amount of food consumed did not differ between treated and untreated plots. Body measurements, weight, and fat content in mice collected from treated and non-treated areas did not differ. The lack of effects found in field and laboratory studies demonstrate minimal direct impacts to mammals that utilize plants and insects as food items.

Potential indirect impacts from application of diflubenzuron on small mammals includes loss of habitat or food items. As previously mentioned in the section on vegetation, terrestrial phytotoxic effects for diflubenzuron are low. Therefore, indirect risk to mammals from impacts to terrestrial plants is expected to be minimal for those species that depend on terrestrial plants as food or habitat. Aquatic plants may also serve as habitat or food items for select mammals. A discussion of the risk to aquatic plants from diflubenzuron applications is provided later in this section; however, in short, diflubenzuron poses minimal risk to aquatic plants.

Another possible indirect risk to mammals that should be considered is the loss of food items for those mammals that eat insects. Diflubenzuron has a wide range of toxicity to different terrestrial invertebrate species and is more selective to immature stages. At the proposed application rates, grasshoppers have the highest risk of being impacted while other taxa have a much reduced risk based on the higher application rates that are needed for control of other taxa, and the lack of effects seen in multiple field studies on invertebrates at use rates much higher than those proposed for the Program. The lower application rates and application buffer zones would minimize impacts to terrestrial invertebrates. Risk of diflubenzuron applications to terrestrial invertebrates are discussed in more detail below in separate section.

Birds

Poisoning of insectivorous birds by diflubenzuron after spraying in orchards at labeled rates is unlikely due to low toxicity (Muzzarelli, 1986). The primary concern for bird species is related to an indirect effect on insectivorous species from a decrease in insect prey after diflubenzuron application rather than direct toxicity from diflubenzuron exposure. Widespread use of diflubenzuron to suppress forest defoliators may lead to harmful effects on forest songbirds by reducing populations of insects upon which they feed (Eisler, 2000). These types of large-scale applications over a large percentage of rangeland would not be anticipated when using RAATs.

Low indirect risk has been documented in multiple field studies designed to assess the loss of invertebrate prey items to select avian species. Small songbirds in a forest ecosystem were not affected after aerial application of diflubenzuron at 350 g a.i./ha (0.31 lb a.i./ac). No effects to the great tit, *Parus major*, or tree sparrow, *Passer montarus*, nestlings were noted based on growth and breeding endpoints as well as the calculated maximum daily intake of insects. Sample et al. (1993) noted a shift in the diet of five of nine songbird species after applications of a 25% formulation of diflubenzuron at a rate of 70.75 g/ha (0.063 lb a.i./ac) to control gypsy moth, which is well above full and RAATs diflubenzuron rates. Overall, insect biomass was the same between treated and untreated sites. Lepidopteran biomass declined in treated areas while Diptera, Coleoptera, Hemiptera, and other orders of insects increased. Shifting diets in insectivorous birds in response to prey densities is not uncommon in undisturbed areas (Rosenberg et al., 1982; Cooper et al., 1990; Sample et al., 1993).

Amphibians and Reptiles

A potential indirect effect of diflubenzuron applications is loss of habitat or food items. Aquatic habitat would consist of aquatic plants while aquatic food items would consist of algae, aquatic invertebrates, and small fish. Indirect risk to amphibians is expected to be minimal because residues do not exceed any effect endpoint for aquatic plants, invertebrates, or fish. The potential terrestrial indirect risk to amphibians and reptiles is also expected to be minimal. Diflubenzuron is not phytotoxic; therefore, risk to terrestrial habitat is minimal. Diflubenzuron is expected to have an effect on terrestrial invertebrates that would serve as a food source; however, due to the selectivity of the insecticide and the range of sensitivities to different invertebrate species, widespread declines are not expected. In addition, the use of the proposed application buffer zones, and in some cases RAATs, would allow rapid recolonization of treated areas (USDA APHIS, 2015).

The above conclusion is supported by a field study that assessed the impacts of diflubenzuron applications to aquatic and terrestrial salamanders (Pauley, 1995a, b). Applications occurred over two large watersheds at a rate of 0.03 lb/ac, which is approximately twice the maximum rate used in the Program. In terrestrial and aquatic salamanders a shift in prey items was noted; however, there was no effect on body size or population in the aquatic salamanders, and no effects on body size or body fat in the terrestrial salamanders (Pauley, 1995a, b).

Fish and Aquatic Invertebrates

Indirect risk to fish species can be defined as a loss of habitat or prey base that provides food and shelter for fish populations. Indirect impacts to aquatic species through the loss of prey items are also not expected based on the available fish and invertebrate toxicity data (USDA APHIS, 2018c).

Data suggests chronic risk to some aquatic invertebrates. However, these findings are based on conservative residue estimates when compared to observed residues that have been measured in the field. In addition, values are based on 21- to 28-day continuous exposure studies. This type of exposure would not occur in this Program because only one application is made per year, and available environmental fate data suggests diflubenzuron would not persist in water (USDA APHIS, 2018c).

The laboratory variability in sensitivities to diflubenzuron is supported by several field studies that have assessed the impacts of diflubenzuron in different aquatic habitats. A review of several aquatic field studies demonstrated that when effects were observed it was at diflubenzuron levels not expected from Program activities (Fischer and Hall, 1992; USEPA, 1997; Eisler, 2000; USDA FSUSDA FS, 2004). While these studies may have limited use because of study design and relevance to the Program, they can provide support to laboratory results and insight into ecosystem level impacts that would not be observed in standard laboratory toxicity studies.

Ali and Mulla (1978a) tested a formulation of diflubenzuron and found that crustaceans, such as cladocerans and copepods, were the most sensitive taxa after two applications to a lake at a rate of 156 g a.i./ha. In addition, mayfly nymphs were severely reduced, supporting other ecosystem-type exposure studies testing the effects of diflubenzuron. Mayfly nymphs were reduced after continuous applications of diflubenzuron in laboratory streams over a 5-month period (Hansen and Garton, 1982). Mayfly nymphs within the genera *Baetis*, *Rithrogena*, *Paralepthophlebia*, and *Ephemerella* were the most sensitive. Coleoptera (family Elmidae), Oligochaeata, and Gastropoda numbers were not affected at the highest test concentration (10 µg/L). The same trend was also observed in other flowing water ecosystems where diflubenzuron application rates of 0.4 to 0.8 oz a.i./acre reduced numbers of dipterans, as well as cladocerans, copepods, mayfly nymphs, corixids, and springtails (Eisler, 1992). Cladocerans and certain aquatic hemipterans have also been shown to be the most sensitive organisms in dosing studies in ephemeral pools (Lahr, 1998). In freshwater lakes, ponds, and marshes, the types of invertebrates most susceptible to diflubenzuron are amphipods (scuds), cladocerans, some midges, caddisflies, and mayflies (Ali and Mulla, 1978b, a; Apperson et al., 1978; Hansen and Garton, 1982; Sundaram et al., 1991; Fischer and Hall, 1992). In particular, cladocerans (*Daphnia* sp.) and caddisflies (*Clistoronia* sp.) are at high risk of adverse effects from full coverage applications of diflubenzuron. Mayflies (*Callibaetis* sp.), amphipods (*Gammarus* sp.), and some midges (*Tanytarsus* sp.) are at moderate risk. Dragonfly naiads, stonefly naiads, aquatic beetles, crayfish, bivalves, chironomid midges, and snails are at low risk. Recovery of invertebrate taxa affected by diflubenzuron at a dose of 10 µg/L has been observed in outdoor pond studies during the duration of the study while other taxa may take longer (Ali and Kok-Yokomi, 1989).

Several studies are available which assessed the direct effects of diflubenzuron to invertebrates, while comparatively few exist which assess effects to fish. Tanner and Moffett (1995) noted effects on fish growth at diflubenzuron levels as low as 2.5 µg/L, while ponds directly treated with diflubenzuron at a concentration of 5 or 13 µg/L did not show any effects on fish growth (Apperson et al., 1978; Colwell and Schaefer, 1980). A shift in diet was noted by Colwell and Schaefer (1980); however, this did not translate into an effect on growth in fish. Boyle et al. (1996) noted diflubenzuron-related impacts to some aquatic invertebrates indirectly resulting in increased algal biomass in an outdoor microcosm dosed bi-weekly or monthly at 10 µg/L. These reductions did not result in indirect impacts to bluegill and largemouth bass.

The Dimilin® 2L label indicates the insecticide is toxic to aquatic invertebrates. The product cannot be applied directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. The label indicates a level, well maintained vegetative buffer strip between areas to which this product is applied and surface water features such as ponds, streams, and springs would reduce the potential for contamination or water from rainfall-runoff. Runoff of this product would be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours. Erosion control practices would reduce this product's contribution to surface water contamination (USEPA, 2017c).

Terrestrial Invertebrates

Grasshoppers provide benefits to the ecosystem, such as facilitating nutrient cycling and providing a critical food supply to wildlife. At the point at which APHIS would chemically treat against grasshoppers with diflubenzuron, it is believed that the environmental damage caused by grasshoppers would far outweigh the benefits that grasshoppers provide.

As previously mentioned, diflubenzuron works by inhibiting chitin production; arthropods (e.g., insects, mites, and crustaceans) use chitin to build their exoskeletons and will die if they are unable to produce it during the molting stage. Diflubenzuron affects all arthropods that ingest it, except adult insects, which do not molt. Therefore, the insecticide has the potential to reduce populations of beneficial terrestrial and aquatic arthropods within the treatment zone.

Diflubenzuron applications have the potential to affect chitin production in various other beneficial invertebrates. Multiple field studies in a variety of application settings, including grasshopper control, have been conducted regarding the impacts of diflubenzuron to terrestrial invertebrates. Based on the available data, sensitivity of terrestrial invertebrates to diflubenzuron is highly variable depending on which group of insects and which life stages are being exposed. Diflubenzuron has greater impact on immature stages of terrestrial invertebrates. Immature grasshoppers, beetle larvae, lepidopteran larvae, and chewing herbivorous (plant-eating) insects appear to be more susceptible to diflubenzuron than other invertebrates (Murphy et al., 1994; Eisler, 2000; USDA FS, 2004). Within this group, however, grasshoppers appear to be more sensitive to the proposed use rates for Dimilin® 2L. The highest use rates in the grasshopper program are still only one half to 48 times less than rates that are used for other invertebrate taxa. Honey bees, parasitic wasps, predatory insects, and sucking insects show greater tolerance to diflubenzuron exposure (Murphy et al., 1994; Eisler, 2000; USDA FS, 2004). Diflubenzuron is moderately toxic to spiders and mites (USDA APHIS, 2018c).

Deakle and Bradley (1982) measured the effects of four diflubenzuron applications on predators of *Heliothis* spp. at a rate of 0.06 lb a.i./ac and found no effects on several predator groups. This supported earlier studies by Keever et al. (1977) that demonstrated no effects on the arthropod predator community after multiple applications of diflubenzuron in cotton fields. Sample et al. (1993) assessed the impacts of forestry applications of diflubenzuron on non-target invertebrates at a rate of 70.75 g a.i./ha (0.063 lb a.i./ac) applied once per year for a 2-year study. On the level of invertebrate order, there were no statistically significant effects between treated and untreated blocks when considering median abundance of the insect orders Lepidoptera, Coleoptera, Diptera, Trichoptera, Hymenoptera, Heteroptera, Homoptera, Neuroptera, and Plecoptera. Within each order, there were significant effects in both years of the study for the moth families Arctiidae and Notodontidae, out of 26 families that were assessed. These results are partially confirmed in another forestry application of diflubenzuron. Butler et al. (1997) measured forestry invertebrate abundance three years post-application to determine potential impacts from gypsy moth applications to non-target invertebrates. Some effects in diversity were noted. Abundance was not statistically significant when samples were taken between treated and untreated sites but some differences were noted in Microlepidoptera and Coleoptera abundance for the year of treatment for a foliage sampling method. While these application rates occurred at levels above those used by the Program, the potential for any impacts on these invertebrates would be assessed within a site-specific NEPA document.

Field studies carried out as part of the grasshopper IPM project indicated that diflubenzuron has minimal impact on most terrestrial non-target arthropods (Catangui et al., 1996). Weiland et al. (2002) in Wyoming monitored the effects of Dimilin® 25W for 21 days post-application on terrestrial invertebrates after full treatment applications of 17.5 and 52.5 g a.i./ha. From high and low sweep net captures (a funnel shaped net swept back and forth in order to capture and count insects), no effect on invertebrates in the orders Homoptera, Hymenoptera, Coleoptera, Hemiptera, Lepidpotera, or Neuroptera were found. There was a statistically significant increase in Diptera and a statistically significant decrease in Araneae (spiders) but the authors question the spider analysis because untreated populations also dropped dramatically during the study. Tingle (1996) assessed the impacts of diflubenzuron applications in two field trials occurring in two separate years with applications of 93 g a.i./ha (0.08 lb a.i./ac). Based on an analysis of 28 taxonomic groupings, only two were affected and included non-target grasshoppers and lepidopteran larvae. This effect only occurred in the treated areas, not in the untreated buffer areas that were sampled.

Grasshopper IPM field studies have shown diflubenzuron to have a minimal impact on ants, spiders, predatory beetles, and scavenger beetles. There was no significant reduction in populations of these species from 7 to 76 days after treatment. Although ant populations exhibited declines of up to 50 percent, these reductions were temporary, and population recovery was described as immediate (Catangui et al., 1996). No significant reductions in flying non-target arthropods, including honey bees, were reported. Within one year of diflubenzuron applications in a rangeland environment, no significant reductions of bee predators, parasites, or pollinators were observed for any level of diflubenzuron treatment (Catangui et al., 1996). Graham et al. (2008) evaluated the impacts of diflubenzuron treatments on aquatic and terrestrial invertebrates for Mormon cricket suppression in Utah. A majority of terrestrial invertebrate taxa were not significantly different pre- and post-treatment among three sites that were evaluated. There was a noted decrease in some ant genera but results were not consistent between sites and not all genera were impacted. Non-ant Hymenoptera showed increased numbers at two of the three sites and a decrease at a third site when comparing numbers pre- and post-treatment. Secondary toxicity of diflubenzuron to invertebrates that could feed on treated grasshoppers via cannibalism or necrophagy has been evaluated. Although based on a small sample size, no acute effects were noted in darkling beetles fed field-collected grasshopper cadavers (Smith and Lockwood, 2003).

Pollinators

Insecticide applications to rangelands have the potential to impact pollinators, and in turn, vegetation and various rangeland species that depend on pollinated vegetation. Based on the review of laboratory and field toxicity data for terrestrial invertebrates, applications of diflubenzuron are expected to have minimal risk to pollinators of terrestrial plants. The use of RAATs provide additional benefits by creating reduced rates and/or untreated swaths within the spray block that will further reduce the potential risk to pollinators.

Although negative effects of diflubenzuron on honeybees have been demonstrated at high application levels and relatively long periods of exposure, these application rates exceed the rates used in the Program. Mommaerts et al. (2006) and Thompson et al. (2005) documented sublethal effects on reproduction related endpoints for the bumble bee, *Bombus terrestris* and the honey bee, *Apis mellifera*, respectively, testing a formulation of diflubenzuron. However, these effects were observed at much higher use rates relative to those used in the grasshopper program. Diflubenzuron application rates as high as 0.125 to 0.25 lb a.i./ac resulted in no effect to adult mortality and brood production (Robinson and Johansen, 1978). A field study in apples where diflubenzuron was applied at 0.357 lb a.i./ac to trees in full bloom with honey bees foraging on the blossoms showed no reduction in adult or larval bee populations (Emmett and Archer, 1980). This rate is well below the 0.016 lb a.i./ac rate that is used for full coverage in the Program. These results support other field studies where diflubenzuron has been shown to have no effect on honey bees in field studies applied at up to 0.5 lb a.i./ac (Atkins et al., 1976; Johansen et al., 1983). In a commercial citrus grove, diflubenzuron was applied eight times at 0.312 lb a.i./ac at approximately monthly intervals to evaluate the impact on honey bee brood. No effects were observed on bee brood development (Schroeder et al., 1980). A similar lack of effects to honey bee broods has been observed with repeated diflubenzuron applications in cotton fields at rates much higher than those used in the Program (Robinson, 1979). Additionally, no significant impacts were seen on honey bees in Catangui et al. (1996), as reported in the section above on terrestrial invertebrates.

The current Dimilin® 2L USEPA-approved product label has minimal protection measures for adult bees because USEPA considers the chemical to be nontoxic to adult bees. However, diflubenzuron is considered toxic to larval bees. The product label indicates that users should minimize exposure of this product to bees and minimize drift to beehives or off-site pollinator habitat. APHIS would adhere to these recommendations.

Human Health

Adverse human health effects from ground or aerial ULV applications of diflubenzuron (the Dimilin® 2L formulation) to control grasshoppers are not expected based on the low acute toxicity of diflubenzuron and low potential for human exposure to diflubenzuron. Diflubenzuron has low acute dermal toxicity in rabbits and very low acute oral and inhalation toxicities in rats. It is a mild eye irritant. Diflubenzuron is not a skin irritant in rabbits, and is negative for skin sensitization in the guinea pig (USEPA, 2015b). The adverse health effects of diflubenzuron to mammals and humans involves damage to hemoglobin in blood and the transport of oxygen. Diflubenzuron causes the formation of methemoglobin. Methemoglobin is a form of hemoglobin that is not able to transport oxygen (USDA FS, 2004). USEPA classifies diflubenzuron as non-carcinogenic to humans (USEPA, 2015b).

The proposed use of diflubenzuron and adherence to label requirements substantially reduces the potential for exposure to humans and the environment. Program workers are the most likely to be exposed by Program applications of diflubenzuron. The surrounding general public is also at risk of exposure. APHIS does not expect adverse health risks to workers based on low potential for exposure to diflubenzuron when applied according to label directions and use of PPE during applications (e.g., long sleeve shirt and pants, chemical-resistant gloves, shoes plus socks, respirator for those mixing and loading chemical). APHIS quantified the potential risks associated with accidental exposure of diflubenzuron for workers during mixing, loading, and application based on proposed Program uses. The quantitative risk evaluation results indicate no concerns for adverse health risk for Program workers from the Program application (http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019)).

Adverse health risk to the general public from diflubenzuron exposure in treatment areas is not expected due to the low potential for exposure (such as low population density in the treatment areas, and adherence to label requirements and Program measures designed to reduce exposure to the public), and low toxicity to mammals. APHIS treatments are conducted in rural rangeland areas consisting of widely scattered, single, rural dwellings in ranching communities, where agriculture is a primary industry. Applications are not made to farm buildings or homes. Program measures beyond those on the label require application buffers from structures as well as aquatic areas reducing the potential for exposure to the public from direct exposure due to drift and from drinking water sources. A detailed discussion about the potential human health risk from diflubenzuron applications are available at http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019).

c. Malathion

Malathion is a broad-spectrum organophosphate insecticide widely used in agriculture on various food and feed crops, homeowner yards, ornamental nursery stock, building perimeters, pastures and rangeland, and regional pest eradication programs. The chemical's mode of action is through AChE inhibition, which disrupts nervous system function. While these effects are desired in controlling insects, they can have undesirable impacts to non-target organisms that are exposed to malathion. The grasshopper program currently uses the malathion end-use product Fyfanon® ULV AG, applied as a spray by ground or air.

Physical Environment

Air

Volatility is not expected to be a major pathway of exposure based on the low vapor pressure and Henry's Law constant that have been reported for malathion (HSDB, 2009). The atmospheric vapor phase half-life of malathion is 5 hours (U.S. National Library of Medicine, 2009).

Water

Degradation of malathion in water is mostly by photolysis and microbial degradation under acidic conditions (pH lower than 7), and chemical transformation under alkaline conditions (pH greater than 7) (Wolfe et al., 1976). The half-life of malathion ranges from 0.67 (natural river water) to 42 days (distilled water) (Howard, 1991). Guerrant et al. (1970) found the malathion half-life in pond, lake, river, and other natural waters varied from 0.5 days to 10 days, depending on pH. Malathion is likely to have longer persistence in acidic aquatic environments. The half-life of malathion was calculated from Program monitoring data for natural waters during the 1997 Medfly Cooperative Eradication Program in Florida to be 8 hours in a retention pond, and 32 hours in the Hillsborough River (USDA APHIS, 1997). Half-life in seawater at pH 8 was 2.6 days (Horvath, 1982). Aerobic and anaerobic aquatic metabolism studies submitted for USEPA registration show half-lives to be short in water and sediment under alkaline conditions. Reported water and sediment half-lives, in an aerobic aquatic metabolism study, were reported as 0.34 to 3.4 days (USEPA, 2016a). USEPA estimated an aerobic aquatic metabolism value for modeling purposes of 3 days based on various aerobic soil metabolism half-life data. The reported half-life in water and sediment for the anaerobic aquatic metabolism study was 2.5 days at a range of pH values from 7.8 to 8.7 (USEPA, 2006).

Soil

The persistence of malathion in soils depends primarily on microorganism activity, pH, and organic matter content (USEPA, 2016a). Persistence is decreased with microbial activity, moisture, and high pH. The half-life of malathion in natural soil varies from 2 hours (Miles and Takashima, 1991) to 11 days (Neary, 1985; USEPA, 2006). USEPA (2016a) reports biphasic half-lives with the initial half-life less than one day followed by half-lives greater than ten days. The primary route of degradation of malathion in surface soils appears to be microbially mediated soil metabolism (half-life <1-2.5 days) and hydrolysis (pH 7 half-life 6.21 days and pH 9 half-life 12 hours) (USEPA, 2000a). Known degradates include malathion monoester, ethyl hydrogen fumarate, diethyl succinate, malathion mono- and dicarboxylic acids, demethyl mono- and dicarboxylic acids, and CO_2 (USEPA, 2000a). The principal degradation products are monocarboxylic and dicarboxylic acids (Walker and Stojanovic, 1973).

Malathion and associated degradates, in general, are soluble and do not adsorb strongly to soils (USEPA, 2000a). Malathion K_{oc} values range from 151 to 183 (USDA FS, 2008b). Inorganic degradation of malathion may be more important in soils that are relatively dry, alkaline, and low in organic content, such as those that predominate in the western program areas. Malathion is subject to hydrolysis under neutral (pH of 7) and alkaline conditions, but is more stable under acidic conditions. It does not penetrate much beyond the soil surface and does not adsorb tightly to inorganic soil particles, although it binds tightly with organic matter (Jenkins et al., 1978). Demethyl and carboxylic acid degradates are expected to be highly mobile, especially in alkaline soil (USEPA, 2000a). Adsorption to organic matter and rapid degradation make it unlikely that detectable quantities of malathion would leach to groundwater (LaFleur, 1979).

Malathion degradation products also have short half-lives. Malaoxon, the major malathion degradation product of toxicological concern, has half-lives less than one day in a variety of soil types (USEPA, 2016a).

Vegetation

The available data demonstrates malathion exhibits low to moderate toxicity to terrestrial plants at Program applications (USDA APHIS, 2015). Effects on reproduction, growth and mortality have been noted at concentrations typically exceeding 1.0 lb ai/acre (USEPA, 2016b). The half-life of malathion on foliage has been shown to range from 1 to 6 days (El-Refai and Hopkins, 1972; Nigg, 1981; Matsumara, 1985; USDA FS, 2008b).

Malathion treatments should greatly reduce grasshopper populations and subsequent damage to rangeland vegetation, surrounding crops, and other vegetation. However, plants may be impacted if malathion decreases populations of terrestrial invertebrate pollinators. This is discussed further in the section below on pollinators. In addition, plants that depend on certain animals for seed dispersal may be impacted from malathion applications. Potential impacts to wildlife are discussed below.

Livestock and Other Grazing Animals

While livestock and horses may graze on rangeland the same day that the land is treated with malathion, the products used by the grasshopper program are labeled with rates and treatment intervals that are meant to protect livestock. Mitigations appearing on the Fyfanon® ULV AG label to protect livestock (and human) health include removing livestock from the area before insecticide application and limiting applications on rangeland to no more than 1 treatment per cutting and a minimum application interval of 7 days (USEPA, 2012b). Tolerances are set for the amount of malathion that is allowed in cattle fat (4 ppm), meat (4 ppm), and meat byproducts (4 ppm) (40 CFR Parts 180.111). The grasshopper program would treat at application rates indicated on product labels or lower, which would ensure approved residues levels. In addition, the Program would make only one application a year.

Wildlife

USEPA found malathion moderately toxic to birds on a chronic basis and is slightly toxic to mammals through dietary exposure, acutely toxic to aquatic species (including freshwater as well as estuarine and marine species) (USEPA, 2000b, 2016b). Toxicity to aquatic vertebrates such as fish and larval amphibians, and aquatic invertebrates is variable based on test species and conditions. Toxicity ranges from moderately toxic to highly toxic to each aquatic group (USEPA, 2016b; USDA APHIS, 2018d). The data available on impacts to fish from malathion suggest levels above those expected from Program applications. Consumption of contaminated prey is not expected to be a significant pathway of exposure for aquatic species based on expected residues and the low bioconcentration factor (BCF; ratio of the concentration of a chemical in an organism to the concentration of the chemical in the surrounding environment) (USEPA, 2016a; USDA APHIS, 2018d). Toxicity to plants, including algae, could result in indirect effects to habitat and food for fish and aquatic invertebrates. However, indirect effects to fish from impacts of malathion applications to aquatic plants are not expected (USDA APHIS, 2018d).

USEPA considers malathion highly toxic to bees if exposed to direct treatment on blooming crops or weeds. The Fyfanon® ULV AG label indicates not to apply product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area (USEPA, 2012b). Toxicity to other terrestrial invertebrates is variable based on the test organism and test conditions however malathion is considered toxic to most terrestrial invertebrates (USEPA, 2016b).

Mammals

Studies suggest there are risks for certain mammal groups that feed within areas treated with malathion. However, the studies are based on doses that are well above Program applications of malathion; malathion would only be applied once per year and residues would not persist due to the rapid breakdown of the parent and other toxic metabolites, such as malaoxon (USDA APHIS, 2018d).

Direct acute and chronic risk of malathion to mammals is expected to be minimal from all malathion application methods, but there is the potential for indirect effects from habitat alteration and loss of food items. Habitat loss from phytotoxic effects of malathion to terrestrial plants is not expected because of the low reported toxicity of malathion to plants. When effects to plants are seen, they were at doses well above Program applications. Indirect risks to mammals resulting from the loss of plants that serve as a food source would also be low due to the low phytotoxicity of malathion. The other possible indirect effect that should be considered is loss of invertebrate prey for those mammals that depend on insects and other invertebrates as a food source. Malathion has a wide variety of sensitivities to insects and a complete loss of invertebrates from a treated area is not expected because of low Program rates and application techniques. In addition, the aerial and ground application buffers and untreated swaths provide refuge for invertebrates that serve as prey for insectivorous mammals and would expedite repopulation of areas that may have been treated.

Limited field studies are available that address the indirect impacts of malathion applications to small mammals. McEwen et al. (1996) found no post-treatment effects on deer mouse populations in North Dakota after grasshopper-related malathion applications. Erwin and Sharpe (1978) assessed the impacts of malathion ULV applications at Program rates and saw no effects on small mammal populations in Nebraska. In another field study chipmunk populations were reduced 30 to 55% after treatment with 2 lb a.i/ac of malathion, which is greater than three times the maximum amount allowed in the Program (Giles and Robert, 1970).

Birds

APHIS expects that direct avian acute and chronic effects would be minimal for most species (USDA APHIS, 2018d). The preferred use of RAATs during application reduces these risks by reducing residues on treated food items and reducing the probability that they will only feed on contaminated food items. In addition, malathion degrades quickly in the environment and residues on food items are not expected to persist.

Indirect effects on mammals from the loss of habitat and food items are not expected because of malathion's low toxicity to plants and the implementation of RAATs that would reduce the potential impacts to invertebrates that serve as prey for avian species. The possible indirect effects of malathion applications to birds have been evaluated in several field studies. A 3-year study was conducted to determine the indirect effects of malathion on survival and growth of Brewer's sparrows (*Spizella breweri*) and sage thrasher (*Oreoscoptes montanus*) nestlings in Idaho (Howe, 1993; Howe et al., 1996). Although the total invertebrate availability was reduced by standard malathion spray applications (0.5 lb a.i./acre), nesting birds were shown to switch their diets to the remaining insects and reproduce as successfully as birds on untreated control plots. Adults had to forage longer on treated plots, and nestlings demonstrated an increased propensity for parasitic blowfly infestations. Either of these indirect effects might impact survival in some situations. However, this particular field study did not show these effects to be significant. Pre-spray grasshopper densities were relatively low (1 to 4 per square yard) on all plots and were significantly reduced in the post-spray period. This probably made the food availability test even more rigorous than would be posed by an actual operational grasshopper suppression project, where pre-spray densities are much higher and even post-spray grasshopper densities usually exceed 1 or 2 per square yard (McEwen et al., 1996).

George et al. (1995) evaluated the effects of grasshopper malathion applications on vesper sparrow (*Pooecetes gramineus*) and horned lark (*Eremophila alpestris*) densities in Colorado, Idaho, North Dakota, Utah, and Wyoming, and found no effect 10 and 21 days post treatment. Dinkins et al. (2002), in a summary of a study conducted in Colorado, reported no effect on horned lark pair densities when comparing fields that had been treated with 0.6 kg/ha of malathion to untreated areas. Norelius and Lockwood (1999) evaluated several different grasshopper insecticides and their potential effects on bird densities. Malathion application were made using RAATs. No negative effects on bird density were noted in the malathion treated blocks.

Pascual (1994) found no effects on the nesting and reproductive success of the blue tit, *Parus caeruleus*, after a forestry application of a ULV malathion formulation at a rate of 1.16 kg a.i./ha or 1.03 lb a.i./ac. Although there was a reduction in some lepidopteran species, others were unaffected. Nest abandonment, nest success, hatching success, nestling mortality, daily survival rate, and nestling weight were not affected.

Amphibians and Reptiles

Available toxicity data demonstrates that amphibians are less sensitive to malathion than fish, discussed below. Malathion residues are more than 560 times below the most sensitive acute toxicity value for malathion, suggesting low direct acute effects from malathion applications (USDA APHIS, 2018d). Studies also suggest a low probability of sublethal impacts from malathion. Sublethal effects, such as developmental delays, reduced food consumption and body weight, and teratogenesis (developmental defects that occur during embryonic or fetal growth), have been observed at levels well above those assessed from the Program's use of malathion (USDA APHIS, 2018d).

Indirect risk is also expected to be low. Relyea and Diecks (2008) observed sublethal impacts to amphibians from the loss of aquatic invertebrates in an outdoor field microcosm study. Dosing occurred weekly for 7 weeks. Dosing levels and frequency of dosing exceed those expected from malathion applications in this Program. Program protection measures for aquatic water bodies and the available toxicity data for fish, aquatic invertebrates, and plants suggest low indirect risks related to reductions in habitat or aquatic prey items from malathion treatments.

Adult amphibians that may forage for terrestrial invertebrates away from aquatic breeding sites could be at risk from the loss of prey items. However, the implementation of application buffers and other Program restrictions from breeding sites that are adjacent to aquatic water bodies, and the available field data regarding malathion impacts to non-target terrestrial invertebrate populations, would suggest that this indirect effect would not occur (Smith et al., 2006).

Available data on malathion reptile toxicity suggest that, with the use of Program meassures, no lethal or sublethal impacts would be anticipated (USDA APHIS, 2015). However, the effects data for reptiles is limited, thus APHIS assessed risks to avian species to determine the potential for risks to reptiles. Program measures such as the use of RAATS will reduce direct effects of malathion applications for reptiles. Indirect risk to reptiles from the loss of food items is expected to be low due to the low application rates and implementation of preferred Program measures such as RAATs (USDA APHIS, 2018d).

Fish and Aquatic Invertebrates

USEPA (2006) provides a review of two field studies in which multiple malathion applications were made over water for mosquito control, and effects to fish were monitored in estuarine environments. Mortality and AChE inhibition were noted in both studies; however, these results have limited use in assessing risk from Program-related malathion applications because rates were much higher than those proposed in the Program. In another USEPA study review, four malathion applications were made to freshwater ponds containing bluegill over an 11-week period. Reductions in bluegill populations were attributed to a loss of aquatic invertebrates at 0.02 and 0.002 mg/L, which is above levels predicted from Program activities using pesticide drift models (USDA APHIS, 2018d). In another review, malathion applications were made within 25 feet of a creek in Alabama and monitored for aquatic invertebrate and fish effects over a 3-year period. A slight reduction in AChE was noted in fish collected at the area of application; however, there were no effects on the population during the study. There were some differences in the abundance of invertebrate taxa, but the authors could not attribute the differences to malathion applications.

The risk to aquatic vertebrates and invertebrates is low for most species; however, some sensitive species that occur in shallow water habitats may be at risk. Program measures such application buffer zones, drift mitigation measures and the use of RAATs will reduce these risks.

Terrestrial Invertebrates

Risks to terrestrial invertebrate populations are anticipated based on the available toxicity data for invertebrates and the broad spectrum activity of malathion. Full treatments (i.e., maximum application with no RAATs) of malathion to control grasshopper populations have been shown to have negative impacts to non-target terrestrial invertebrates including some coleopterans and field crickets within the first week of application (Swain, 1986; Quinn et al., 1991). The risk to terrestrial invertebrates can be reduced by the implementation of application buffers and the use of RAATs, which would reduce exposure and create refuge areas where malathion impacts would be reduced. Smith et al. (2006) conducted field studies to evaluate the impacts of grasshopper treatments to non-target terrestrial invertebrates and found minimal impacts when making reduced rate applications with a reduced coverage area for a ULV end-use product of malathion. The potential for long-term exposure and effects to terrestrial invertebrates decreases quickly because the residual toxicity of malathion is approximately 4 days. Any potential for site-specific impacts to terrestrial invertebrates would be assessed in a separate environmental document prior to treatment.

Pollinators

Impacts to pollinators have the potential to be significant, based on available toxicity data for honey bees that demonstrate high contact toxicity from malathion exposures (USDA APHIS, 2018d). However, risk to pollinators is reduced because of the short residual toxicity of malathion. In addition, the incorporation of other mitigation measures in the Program, such as the use of RAATs and wind speed/direction mitigations that are designed to minimize exposure, reduce the potential for population-level impacts to terrestrial invertebrates.

Human Health

Adverse human health effects from ULV applications of malathion (Fyfanon® ULV AG end-use product) to control grasshopper are not expected based on the low mammalian acute toxicity of malathion and low potential for human exposure. Malathion has low acute dermal toxicity and very low acute oral and inhalation toxicities in rats. It causes slight eye conjunctival irritation in rabbits that clears in seven days, and slight dermal irritation in rabbits. Malathion is not a dermal sensitizer in guinea pig. Malathion inhibits AChE in the central and or peripheral nervous system with clinical signs of neurotoxicity that include tremors, salivation, urogenital staining, and decreased motor activity (USEPA, 2016c). Exposure to high levels of malathion may cause difficulty breathing, chest tightness, vomiting, cramps, diarrhea, watery eyes, blurred vision, salivation, sweating, headaches, dizziness, loss of consciousness, and death (ATSDR, 2003). USEPA indicates that malathion has "suggestive evidence of carcinogenicity but not sufficient to assess human carcinogenic potential" (USEPA, 2016c).

Program measures related to insecticide applications near areas of human development and adherence to label requirements substantially reduces the potential for exposure to humans. Humans that are most likely to be exposed to malathion include Program workers and the general public. APHIS does not expect adverse health risks to workers based on low potential for exposure to malathion when applied according to label directions and use of PPE during applications (e.g., long-sleeved shirt and long pants, shoes plus socks, and chemical resistant gloves). APHIS quantified the potential health risks associated with accidental worker exposure to malathion during loading for ULV applications in a closed system. The quantitative risk evaluation results indicate no concerns for adverse health risk for Program workers (http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019)).

Adverse health risks to the general public from malathion exposure is also not expected due to low potential for exposure (such as low population density in the treatment areas, and adherence to label requirements and Program measures designed to reduce exposure to the public). APHIS treatments are conducted in rangeland areas consisting of widely scattered, single, rural dwellings in ranching communities, where agriculture is a primary industry. Label requirements to reduce exposure include minimizing spray drift, avoidance of water bodies and restricted entry interval. Program measures such as applying malathion once per season, lower application rates, application buffers and other measures further reduce the potential for exposure to the public. Detailed discussions on the evaluation of potential human health risks are available at:

http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019).

Socioeconomic Impacts

APHIS would only use insecticides to suppress rangeland grasshoppers when the agency believes there would be an economic advantage to the livestock industry. Insecticides applied using the RAATs strategy is expected to provide further economic advantages due to effective treatment at reduced costs. The economics of the RAATs strategy has been studied by both Foster et al. (2000), and Lockwood and Schell (1997). In summarizing both studies (which used various rates of insecticide below the conventional rates for suppression of rangeland grasshoppers and treated less area), the results concluded that treatment costs, under this alternative, when compared to the costs for conventional treatments for rangeland grasshopper infestations, were reduced as follows: 38 to 62% with malathion, 57 to 66% with carbaryl, and 56% with diflubenzuron.

Another potential economic benefit of chemical treatment of grasshoppers is to crop growers near rangelands. With chemical treatments, there would be less potential for rangeland grasshoppers to move to surrounding croplands. In turn, the general public could see economic benefits from this alternative because losses, and therefore costs, of meat, crops, and their byproducts should not be significantly affected. Additionally, less grasshoppers moving to surrounding croplands could mean less of a need for costly chemical treatments by individuals at these sites.

There is the potential for surrounding organic farms to be negatively impacted by Program insecticide applications; however, mitigations such as buffers (see section titled “Additional Treatment Requirements”) are meant to protect adjacent environments from runoff and insecticide drift. These protective measures are expected to protect surrounding organic farms, as well as other areas of concern, from the risk of inadvertent exposure to rangeland insecticide treatments.

The public uses rangelands for recreational activities such as camping, fishing, hiking, and biking. The public may temporarily lose the use of rangeland during and directly after insecticide applications. However, the preservation of vegetation is expected to benefit recreational activities in the long-term by preserving their aesthetic value.

For a summary of potential environmental impacts from each of the chemicals proposed for use under alternative 1, see table 3-2.

Table 3-2. Summary of Potential Impacts from Insecticide Applications under Alternative 1

Insecticide	Vegetation	Livestock	Mammals	Birds	Amphibians and Reptiles	Fish and Aquatic Invertebrates	Non-target Terrestrial Invertebrates/ Pollinators	Human Health
Carbaryl	Minimal risks	Minimal risks	Moderate risks	Moderate risks	Minimal to moderate risk Risk reduced with program measures	Moderate risks for aquatic invertebrates Minimal risks to fish	Ants shown to be negatively impacted in field studies Although limited field data on honeybees, reduced risk anticipated with use of mitigations	Minimal risks
Diflubenzuron	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Potential for risks that can be mitigated with buffers and RAATs	Potential for risks that are mitigated with RAATs Potential risk to pollinator are minimized through use of mitigations Risk reduced using RAAT and bait applications	Minimal risks
Malathion	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Minimal to moderate risk Risk reduced with program measures	Potential for risks that can be mitigated with buffers and RAATs	Risk of impacts could be significant Risks can be reduced by mitigations	Minimal risks

Alternative 2. No Suppression Program

Under the no suppression alternative, APHIS would not fund or participate in any program to suppress grasshopper infestations on rangelands with chemical treatments. Therefore, one of two scenarios could occur: 1) Federal land management agencies, State agriculture departments, local governments, and private groups or individuals attempt to treat chemically grasshoppers on rangelands, without any assistance from APHIS, or 2) no chemical treatments of grasshoppers on rangelands.

Federal land management agencies, State agriculture departments, local governments, and private groups or individuals could chemically treat and suppress grasshopper populations in a manner similar to APHIS. Therefore, APHIS would expect to see similar environmental impacts as described under the sections for the no action or adaptive management alternatives. However, it is also possible that without the technical assistance and Program coordination that APHIS provides during grasshopper programs, that a large amount of insecticides, including those APHIS considers too environmentally harsh but labeled for rangeland use, could be applied, and perhaps misapplied, in efforts to suppress or even locally eradicate grasshopper populations. As of February, 2018, approximately 100 pesticide products were registered by USEPA for use on rangelands and against grasshoppers (Purdue University, 2018). It is not possible to predict accurately all of the environmental consequences of other groups using chemical treatments to suppress grasshopper populations because the type and amount of insecticides that could be used under this scenario are unknown. It is possible that impacts would be much greater than under the no action or adaptive management alternatives due to lack of treatment knowledge or coordination among the groups.

The potential environmental impacts from not applying chemicals on rangelands stem primarily from grasshoppers consuming vast amounts of vegetation in rangelands and surrounding areas and will be discussed in greater detail below.

<u>Natural Resources</u>

A prime habitat for grasshoppers is rangelands. Rangeland is a valuable agricultural resource for livestock production and provides food and habitat for wildlife. Rangelands include natural grasslands, savannas, wetlands, deserts, tundra, and certain forb and shrub communities (USEPA, 2017a). Rangelands have native vegetation, predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing by domestic livestock or wild animals. These plants protect soil from erosion and maintain watersheds for rivers and streams.

Grasshoppers are general feeders, eating grasses and weeds first and often moving to cultivated crops. As discussed in detail in chapter 1, some grasshoppers cut grass stems and blades, eating only a part of the plant. Other types of grasshoppers eat closer to the ground than livestock does, feeding primarily on the growing part of grasses. Others still cut off seed stalks, eliminating seed production, causing a huge reduction in grasses. The economic damage resulting from high grasshopper density of one or several species and the resulting defoliation may reach an economic threshold. Economic threshold is defined as the point where the damage caused by grasshoppers exceeds the cost of controlling the grasshoppers. At this point, rangeland managers save money by treating the grasshoppers to prevent further damage. This threshold is determined by density surveys conducted by the Program and the value of the rangeland's plant resource. The economic threshold is an important tool in grasshopper management as a way of determining economic costs and benefits. Rashford et al. (2012) determined that during typical grasshopper infestation years, approximately 20% of forage rangeland is removed, valued at a dollar adjusted amount of $900 million. This value represents 32 to 63% of the total value of rangeland across the western states (Rashford et al., 2012). Other market and non-market values such as carbon sequestration, general ecosystem services, and recreational use may also be impacted by pest outbreaks in rangeland.

Vegetation damage during serious grasshopper outbreaks may be so severe that all grasses and forbs are destroyed; thus, plant growth is impaired for several years. Rare plants may be consumed during critical times of development such as seed production, and loss of important plant species, or seed production may lead to reduced diversity of rangeland habitats, potentially creating opportunities for the expansion of aggressive and exotic weeds (Lockwood and Latchininsky, 2000).

When grasshoppers consume plant cover, soil is more susceptible to the drying effects of the sun, making plant roots less capable of holding soil in place. Soil damage results in erosion and disruption of nutrient cycling, water infiltration, seed germination, and other ecological processes which are important components of rangeland ecosystems (Latchininsky et al., 2011).

Livestock and Other Grazing Animals

Livestock and horses would accidentally consume a small amount of grasshoppers during an outbreak. Grazing animals typically consume grasshoppers when they are immobile during one of the molting stages (Drolet et al., 2009). However, with the density of grasshoppers reaching significantly high levels, grasshoppers begin to compete with livestock for food by reducing available forage (Wakeland and Shull, 1936; Belovsky, 2000; Pfadt, 2002; Branson et al., 2006; Bradshaw et al., 2018).

Wildlife

Various animals that consume grasshoppers such as rodents, foxes, and birds, would experience a temporary increase in food supply during periods of high grasshopper density. In contrast, some wildlife could be temporarily displaced due to habitat loss from grasshoppers feeding on vegetation. Animals that consume plants would see a huge reduction in food supply and could therefore have temporary decreases in population or could be displaced temporarily to find food elsewhere. Pollinators could see reductions in populations or would need to find alternate sources of nectar and pollen nearby.

If soils are stripped of vegetation due to grasshopper infestation, this could lead to soil erosion and result in sediment problems in water, in turn potentially impacting local fish populations.

Human Health

When there are no chemical treatments, impacts to humans from no suppression efforts from any group fall mainly under socioeconomic impacts.

Socioeconomic Impacts

If rangelands with high densities of grasshoppers are left untreated, livestock owners are expected to experience high economic impacts. Ranchers could offset some of the costs by leasing rangeland in another area and relocating their livestock, finding other means to feed their animals by purchasing hay or grain, or selling their livestock. Ranchers could also incur economic losses from personal attempts to control grasshopper damage. Local communities could see adverse economic impacts to the entire area. Grasshoppers that infest rangeland could move to surrounding croplands. Farmers could incur economic losses from attempts to control chemically grasshopper populations or due to the loss of their crop(s). The general public could see an increase in the cost of meat, crops, and their byproducts.

While certain individuals may seek out activities to witness grasshopper outbreaks, it is also likely that the public would temporarily choose to avoid using rangeland during severe grasshopper outbreaks. Reductions in vegetation and wildlife dependent on the vegetation, could temporarily keep recreationists away from rangelands. Surrounding private residences and commercial properties could have increased grasshopper infestations.

Alternative 3. Insecticide Applications at Conventional Rates or Reduced Agent Area Treatments (RAATs) with Adaptive Management Strategy (Preferred Alternative)

The adaptive management alternative, the preferred alternative, is expected to have equal or fewer impacts than alternative 1. The differences between alternative 1 and alternative 3 is the addition of the use of a new chemical treatment, chlorantraniliprole, and the use of adaptive management, which enables the Program to treat with other insecticides registered by USEPA for use on rangelands against grasshoppers and Mormon crickets. APHIS would review any new insecticides considered for Program use for its risks to human health, livestock health, non-target organisms, and the environment and compare these risks to risks associated with insecticides currently used in the Program. The risks posed by the new insecticide must be similar to or less than the risks posed by current insecticides used in the Program. The public would be notified of APHIS' findings and would be given a chance to comment. Insecticides that pose a greater risk than those currently used in the Program would require a supplement to the EIS.

Because a site-specific EA would need to be written around the time that APHIS would chemically treat grasshoppers in an outbreak, any additional insecticides considered under the adaptive management alternative would also be reviewed within the EA. Therefore, the public would have another opportunity to comment on Program use of any additional chemicals.

Potential Impacts of Chlorantraniliprole Applications

Potential impacts of carbaryl, diflubenzuron, and malathion under alternative 3 are the same as those discussed under alternative 1, the no action alternative. The various treatment strategies such as baits versus sprays, ground versus aerial applications, and conventional treatment rates versus RAATs strategies, also remain unchanged. Impacts of these three chemicals and the various treatment strategies have already been discussed within this chapter. This section will focus on the potential environmental impacts from using chlorantraniliprole on rangelands.

Chlorantraniliprole is an insecticide from a relatively new class of insecticides, anthranilic diamides. Anthranilic diamides activate the ryanodine receptor, releasing stored calcium and causing impaired regulation of muscle contraction (Cordova et al., 2006). DuPont's Prevathon®, which is a spray, is the only chlorantraniliprole product currently registered by USEPA for use on rangeland. The product is most effective when the pest ingests treated plant material; affected insects will rapidly stop feeding, become paralyzed, and typically die within 1 to 3 days (USEPA, 2017e). The insecticide is labeled for commercial use as a foliar application to control grasshoppers and various moths, beetles, and caterpillars.

USEPA has registered chlorantraniliprole as a reduced-risk pesticide. Chlorantraniliprole is a low use rate insecticide that has reduced human health and ecological risk when compared to other insecticides, including carbaryl and malathion. Similar to the other chemicals analyzed in alternative 1, chlorantraniliprole's application rates for grasshopper control are lower than rates used by private landowners. See table 3-3 for a summary of use rates.

Table 3–3. Alternative 3 Labeled Rates (lb. ai./acre) for Grasshopper Control

	Maximum Labeled Grasshopper Rate	APHIS Full Rate	APHIS Maximum RAATs Rate	APHIS Average RAATs Rate
Carbaryl (Spray)	1.5	0.5	0.25	0.1875
Diflubenzuron	0.031	0.016	0.012	0.006
Malathion	0.928	0.619	0.309	0.248
Chlorantraniliprole	0.05	0.027	0.0135*	TBD

*These rates may decrease with additional field-testing; however, the maximum full/RAATs will be used in this assessment.

Physical Environment

Air

Chlorantraniliprole is not expected to volatilize significantly based on the reported low vapor pressure at variable temperatures (USEPA, 2008b). Due to the physical properties of chlorantraniliprole, significant exposure to non-target organisms would not be anticipated from volatilization.

Water

Chlorantraniliprole is susceptible to degradation in the presence of light with an aqueous photolysis half-life of 0.31 days but is stable to hydrolysis at a pH of 7. Microbial degradation in the presence or absence of oxygen is comparable with an aerobic aquatic metabolism half-life of 125 to 231 days and an anaerobic aquatic metabolism half-life of 208 days. Solubility is low at a range of relevant pH values (USEPA, 2008b).

Soil

Under alternative 3, by chemically treating rangeland with the insecticide chlorantraniliprole, vegetation would be preserved, therefore, less soil erosion would be expected. Chlorantraniliprole is expected to persist in soil. The Koc values range from 153 to 526 depending on the soil type, suggesting the parent material may be mobile, thus resulting in a greater chance of moving off-site during rain events. Available laboratory soil metabolism studies show half-lives for chlorantraniliprole range from 228 to 924 days (USEPA, 2008b). Approximately five metabolites were noted in soil metabolism studies with none of the metabolites comprising greater than 10% of the parent with the exception of the metabolite IN-EQW78, which composed 33% or greater of the parent compound at temperatures exceeding 35ºC.

Vegetation

Direct effects to terrestrial plants are not expected from chlorantaniliprole because of its low application rate and lack of phytoxicity at relevant doses. Indirect risk through the loss of pollinators from treatments is also not expected to be significant. While vegetation damage from grasshoppers will still occur, chlorantraniliprole treatments should greatly reduce grasshoppers' damage to rangeland vegetation and surrounding crops and other vegetation.

Available data indicates that chlorantaniliprole residues do not persist on vegetation. Dissipation half-life values were typically less than 4 days on various crops (Kar et al., 2012; Malhat et al., 2012). Available aquatic plant toxicity data suggests low toxicity of chlorantraniliprole to freshwater and marine diatoms and algae, as well as aquatic macrophytes (USDA APHIS, 2018b).

Chlorantraniliprole non-target tests using a 20% soluble concentrate formulation demonstrates low toxicity in terrestrial plant seedling emergence and vegetative vigor studies (USEPA, 2008b). The terrestrial plant species that were tested are required by USEPA for pesticide registration and represent monocots and dicots of various agricultural crops (USDA APHIS, 2018b).

Livestock and Other Grazing Animals

While livestock and horses may graze on rangeland the same day that the land is treated with chlorantraniliprole, the products used by the grasshopper program are labeled with rates and treatment intervals that are meant to protect livestock. Label mitigations for various uses include limiting chlorantraniliprole applications on rangeland to no more than 4 times per acre per year, a minimum of 7 days between applications, and no more than 0.2 pounds of active ingredient per acre per year. Tolerances are set for the amount of chlorantraniliprole that is allowed in cattle fat (0.5 ppm), meat (0.1 ppm), and meat byproducts (0.5 ppm) (40 CFR Parts 180.628). The grasshopper program would treat at use rates lower than indicated on the label and would make only one treatment in a year, which is lower than the maximum number of treatments allowed on the label, ensuring approved residue levels in cattle.

Wildlife

USDA APHIS (2018b) assessed the available literature regarding the toxicity of chlorantraniliprole to animals. In summary, the report indicates the chemical is of low toxicity to most terrestrial invertebrates, practically non-toxic to honeybees, low toxicity to fish, and is practically nontoxic to birds and mammals (USDA APHIS, 2018b). Aquatic invertebrates are more sensitive to chlorantraniliprole when compared to fish (USDA APHIS, 2018b). No reptile toxicity data appears to be available. In those cases where reptile toxicity data is not available, the avian data has been used as a surrogate to characterize sensitivity to reptiles. Chlorantraniliprole would be expected to be practically nontoxic to reptiles based on the available avian toxicity data (USDA APHIS, 2018b). The lack of toxicity in other insect groups at rates that are toxic to grasshoppers is related to the activity of chlorantraniliprole, which is primarily through ingestion. Insects such as grasshoppers and larval Coleoptera and Lepidoptera would receive a larger dose from consuming treated plant material compared to many of the non-target pests that do not eat plants that have been evaluated.

Chlorantraniliprole has fewer field studies applicable to rangelands than the other chemicals that may be used in this Program because it is a relatively new insecticide. Use measures and mitigations would depend more heavily on laboratory data.

Fish and Aquatic Invertebrates

Effects to fish and other aquatic biota from consumption of contaminated aquatic prey are not expected to be a significant pathway of exposure for chlorantraniliprole, based on the low residues and low BCF values in aquatic systems (USDA APHIS, 2018b). Direct impacts to aquatic plants are also not anticipated because of the estimated environmental residues and available data for five aquatic plants (USDA APHIS, 2018b). Residues are approximately four orders of magnitude below the lowest effect concentration, suggesting that effects to aquatic plants are not expected. Aquatic plants also provide habitat to fish and aquatic invertebrates by providing shelter and food. These indirect effects to fish and aquatic invertebrates would not be expected based on the low estimated residues.

Amphibians and Reptiles

The direct risk to amphibians and reptiles from chlorantraniliprole is expected to be minimal (USDA APHIS, 2018b). Based on the available effects data and the expected aquatic concentrations, direct effects are not expected on amphibian aquatic life stages. Based on assumptions by USEPA-OPP, the risk to reptiles and amphibians is assumed to be represented by birds and fish, respectively. While there is uncertainty in these types of extrapolations, they can be of some use in cases where limited data is available. No amphibian toxicity data is available for chlorantraniliprole; therefore, the low risk to fish was also assumed to be the same for amphibians.

A potential indirect effect of chlorantraniliprole applications is loss of habitat or food items. Aquatic habitat would consist of aquatic plants while aquatic food items would consist of algae, aquatic invertebrates, and small fish. To better understand the potential indirect effects of these applications, chlorantraniliprole levels were compared to the available chlorantraniliprole effects data for aquatic plants, invertebrates and fish (USDA APHIS, 2018b). Indirect risk to amphibians is expected to be minimal because expected residues do not exceed any effect endpoint for aquatic plants, invertebrates, or fish. The potential for terrestrial indirect effects to amphibians and reptiles is also expected to be minimal. Chlorantraniliprole is not phytotoxic; therefore, risk to terrestrial habitat is minimal. Chlorantraniliprole is expected to have an effect on some terrestrial invertebrates that could serve as a food source but because of its selectivity, the use of RAATs, and application buffer zones, these impacts are not expected to be significant to invertebrate populations.

Terrestrial Invertebrates

Available data for terrestrial invertebrates demonstrates that chlorantraniliprole has low toxicity to most non-target invertebrates. Grasshopper nymphs appear to be much more susceptible to the impacts of chlorantraniliprole than other insect groups. Chlorantraniliprole does have activity against Lepidoptera and some Coleoptera larvae but at rates that are higher than those proposed in the grasshopper program. Bradshaw et al. (2018) found no impacts to three beneficial arthropod taxa after treatment with chlorantraniliprole to small field plots of various grass species. No impacts were noted in sweep net samples of Araneae (spiders), Braconidae (parasitic wasp), and Coccinellidae (lady beetles). Available field studies in turf indicate that there is no risk to non-target invertebrates such as ants, ground beetles, and other ground dwelling invertebrates after treating turf at rates twice those proposed for RAATs (Larson et al., 2012).

Pollinators

Semi-field data suggests that lethal and sublethal risk to pollinators such as Hymenoptera is very low and not expected to result in significant impacts. Available laboratory, semi-field, and field studies demonstrate low toxicity to honey and bumble bees, where no lethal or sublethal impacts have been observed at rates well above those proposed for use in the grasshopper program (USDA APHIS, 2018b).

Human Health

Chlorantraniliprole has a low risk to human health based on its low mammalian toxicity and low probability of exposure to humans which is due to label requirements and other Program measures designed to protect human health. Chlorantraniliprole is not acutely toxic to mammals. It has no adverse short-term effects at relevant doses. The non-adverse effects from short-term toxicity studies included induction of liver enzymes and subsequent increase in liver weights, and increased microvesiculation of the adrenal cortex in male rats without adrenal cellular degeneration or toxicity (USEPA, 2012c). Chlorantraniliprole is not neurotoxic, immunotoxic, carcinogenic, genotoxic, nor is it a developmental toxicant. Chlorantraniliprole demonstrates a lack of effects on maternal or fetal rats and rabbits in oral exposure studies. An oral chronic study on rats reported adverse effects in white blood cells and the liver (USEPA, 2012c).

Adherence to label requirements and additional Program measures designed to reduce exposure to workers (e.g., PPE requirements include long-sleeved shirt and long pants and shoes plus socks) and the public (e.g., mitigations to protect water sources, mitigations to limit spray drift, and restricted-entry intervals) result in low health risk to all human population segments (also see section titled "Potential Impacts of Program Treatment Techniques and Strategies" which includes discussions on baits, RAATs, and other mitigated measures). Detailed discussions on the evaluation of potential human health risks are available at http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019).

Socioeconomic Impacts (Economic costs of program)

Socioeconomic impacts from alternative 3 are expected to be similar to those discussed in alternative 1. Insecticides would only be used to suppress rangeland grasshoppers when the agency believes there would be an economic advantage to the livestock industry. There would be additional potential benefits to surrounding croplands. In turn, the general public could see economic benefits from this alternative because losses, and therefore costs of meat, crops, and their byproducts should not be significantly affected. There would also be less potential for rangeland grasshoppers to move to surrounding private residences and commercial businesses, potentially leading to less chemical treatments by individuals at those sites.

The public uses rangelands for recreational activities such as camping, fishing, hiking, and biking. The public would temporarily lose the use of rangeland during insecticide applications. However, the preservation of vegetation is expected to benefit recreational activities.

Table 3-4. Summary of Potential Impacts from Insecticide Applications under Alternative 3

Insecticide	Vegetation	Livestock	Mammals	Birds	Amphibians and Reptiles	Fish and Aquatic Invertebrates	Non-target Terrestrial Invertebrates/ Pollinators	Human Health
Carbaryl	Minimal risks	Minimal risks	Moderate risks	Moderate risks	Minimal to moderate risk Risk reduced with program measures	Moderate risks for aquatic invertebrates Minimal risks to fish	Ants shown to be negatively impacted in field studies Although limited field data on honeybees, reduced risk anticipated with use of mitigations	Minimal risks
Diflubenzuron	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Potential for risks that can be mitigated with buffers and RAATs	Potential for risks that are mitigated with RAATs Potential risk to pollinator are minimized through use of mitigations Risk reduced using RAAT and bait applications	Minimal risks
Malathion	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Minimal to moderate risk Risk reduced with program measures	Potential for risks that can be mitigated with buffers and RAATs	Risk of impacts could be significant Risks can be reduced by mitigations	Minimal risks
Chlorantraniliprole	Minimal risks	Minimal risks	Minimal risks	Minimal risks	Lack of amphibian and reptile data, however, minimal risks anticipated	Minimal risk to aquatic invertebrates and fish	Minimal risks	Minimal risks

Cumulative Impacts

Cumulative impacts, as defined by the Council on Environmental Quality (CEQ), is "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR § 1508.7). CEQ recognizes the evidence suggesting that the most devastating environmental impacts may not result from the direct impacts of an action, but from the combination of minor impacts of multiple actions over time (CEQ, 1997). This section evaluates the potential cumulative impacts of a Program action when added to other past, present, and reasonably foreseeable future actions regardless of what Federal or non-Federal agency or person takes such actions. This section combines the cumulative impacts discussion for alternatives 1 and 3 since both alternatives include the use of insecticides.

Alternative 2 (no suppression)

Under alternative 2, USDA-APHIS does not take part in any grasshopper suppression program. Alternative 2 could allow for the continued increase in grasshopper populations and potential expansion of populations into neighboring rangeland.

As described in the environmental consequences section, State and private land managers could apply insecticides to manage grasshopper populations. Under this alternative, APHIS would not coordinate treatments. Insecticides labeled for use to manage grasshoppers on rangeland include RAAT information. Land managers would consider using RAATs because this application approach reduces costs. However, land managers may opt not to use RAATs, which would increase insecticides applied to the environment. An increase in insecticides from the lack of coordination and not using RAAT applications where suitable could increase the exposure risk to non-target species and the environment. In addition, land managers may not employ the extra Program measures designed to reduce exposure to the public and the environment as described in the section "Potential Impacts of Program Treatment Techniques and Strategies". Land managers have available the same insecticides as proposed in alternatives 1 and 3, and would apply the insecticides at label rates. Land managers may select other products and insecticides labeled for use against grasshoppers that are not part of the grasshopper suppression program due to their lack of efficacy or environmental concerns.

Alternatives 1 (no action) and 3 (preferred alternative)

Alternatives 1 and 3 involve the use of insecticides under different application methods. Both alternatives include the insecticides carbaryl, diflubenzuron, and malathion. Alternative 3 includes the insecticide chlorantraniliprole. USDA-APHIS keeps records of its grasshopper insecticide applications. Records indicate the Program manages outbreaks every year but not in the same location every year. In 2010, APHIS experienced the largest grasshopper outbreak since 1987, treating 1.26 million acres consisting of 894,662 acres of federal lands, 309,473 acres of private land, and 60,562 acres of state land (USDA APHIS, 2011). Between 2006 and 2017, APHIS funded insecticide applications every year, but the number of acres treated varied significantly (figure 3-1). This variation mostly follows the grasshopper population cycles, although available funding support adds to the variation.

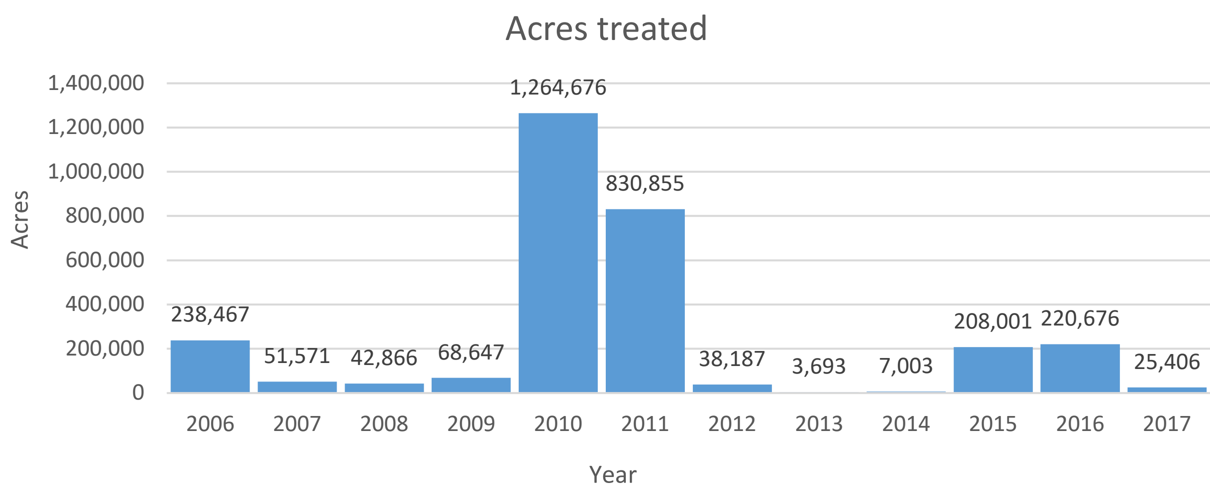

Figure 3-1. Actual acres treated in the grasshopper program from 2006 to 2017.

The Program applies an insecticide application once during a treatment. The Program may treat an area with different insecticides, but does not overlap the treatments. The Program does not mix or combine insecticides.

Based on historical outbreaks in the United States, the probability of an outbreak occurring in the same area where treatment occurred in the previous year is unlikely; however, given time, populations eventually will reach economically damaging thresholds and require treatment. The insecticide application reduces the insect population down to levels that cause an acceptable level of economic damage. The duration of treatment activity, which is relatively short since it is a one-time application, and the lack of repeated treatments in the same area in the same year reduce the possibility of significant cumulative impacts.

In most years, the Program uses aircraft to apply insecticide treatments. The Program uses diflubenzuron more than carbaryl. Of the total acres treated between 2006 and 2017, 93% received diflubenzuron. The Program has not used malathion since 2009. Diflubenzuron is effective against the nymph stages and treats grasshoppers before they reach sexual maturity. In addition, carbaryl bait treatments allow a more selective application to treat grasshoppers. Treating grasshoppers before they reach sexual maturity and using baits to increase selectivity to grasshoppers minimize the potential for cumulative impacts by reducing the need to make future treatments.

Available risk assessments for each Program insecticide shows minimal risk to humans, mammals, and birds based on their intended use pattern, e.g., RAATs, and toxicity data. The risk to terrestrial non-target species is greatest in the area of treatment. As described previously in this chapter, the Program follows label precautions and imposes additional mitigations to reduce the risks to fish, aquatic invertebrates, and non-target terrestrial invertebrates and pollinators.

The potential for cumulative acute or chronic impacts to human health, and in particular, the public are not expected based on how and where treatments are typically made in the Program. Treatments may occur near residential areas but are not within residential areas. As described previously in this chapter, the Program applies application buffers and other practices to minimize exposure to the public, including those who may be sensitive to chemicals. Residents are provided with contact information for the appropriate Federal and State agencies should any questions or concerns arise.

The use of insecticides can result in various potential cumulative impacts, regardless of the pest program. Issues that may have cumulative impacts when using insecticides in a pest management program include:

- insect pest resistance;
- chemical mixture effects to human health and the environment; and
- persistence and bioaccumulation.

Insects can develop resistance to insecticides. Cumulative impacts related to potential grasshopper resistance to the insecticides are not anticipated. The Program uses ULV and RAATs to reduce the amount of insecticides applied in the environment, which also will help to mitigate the development of insect resistance to the insecticides. Grasshopper outbreaks in the United States occur cyclically so applications do not occur to the same population over time that could result in selection pressure increasing the chances of insecticide resistance. The Program is unlikely to reapply insecticides in the same year to the same area or the following year to the same area. Other entities, such as private landowners, may make applications; however, those treatments would not be funded by APHIS. Resistance in other pests that may occur in treated areas is also not anticipated since treatments are focused on grasshoppers using application methods and timing that are conducive to maximizing efficacy of suppression treatments.

The Program decides to implement suppression treatments based on the spatial and temporal factors of a grasshopper outbreak, as well as funding contributions from the States and private landowners when applying to non-Federal lands. This makes it difficult to predict the Program's potential overall insecticide usage. In addition, since the insecticides proposed for use in the Program have a variety of agricultural and non-agricultural uses, there may be an increased use of these insecticides in an area under suppression when private, State, or Federal entities make applications to control other pests. That said, the increased insecticide loading during an outbreak relative to other uses is expected to be minor, and not result in a significant cumulative impacts based on how the Program uses the insecticides.

Other APHIS programs may also apply insecticides in areas where outbreaks of grasshoppers have occurred in the past and could occur in the future. Currently, APHIS Plant Protection and Quarantine (PPQ) programs such as the boll weevil eradication program, which may use diflubenzuron and malathion, the fruit fly cooperative eradication program, which may use malathion, and the gypsy moth cooperative eradication program, which may use diflubenzuron, operate in States that are part of this EIS's geographic scope. In addition to APHIS-PPQ treatments, APHIS Wildlife Services may use pesticides and non-chemical control methods for management of vertebrate pests in areas where grasshopper and Mormon cricket treatments may occur. Estimating the potential for overlap between APHIS programs is difficult due to uncertainty in where pests may occur and what new pests may be detected in the future, and which ones will require insecticide treatment. A site-specific EA would better address potential program overlap areas. However, it is unlikely there would be significant overlap between most APHIS-PPQ programs and the grasshopper program because those mentioned above would not occur in rangeland habitats. There is the potential for overlap in program activities between PPQ and WS since vertebrate management tools may be used in rangeland areas.

Other Federal and State agencies and individuals that own or manage rangelands also may use pesticides for control of invasive plants. Commonly used herbicides on rangelands include auxin-like growth regulators that selectively control broadleaf species (e.g., 2,4-D, aminopyralid, clopyralid, dicamba, fluroxypyr, picloram, and triclopyr), glyphosate, imidazolinone and sulfonylurea herbicides that disrupt the synthesis of amino acids essential for plant growth (DiTomaso et al., 2010). Federal and State weed control programs may release biological control agents to manage weeds. Insecticide sprays in the grasshopper program may adversely affect the biocontrol agents. A coordination of treatments between pest management programs would mitigate this impact. Federal, State and County agencies may also use insecticides to address public health issues such as mosquito control. Larvicide treatments include microbial and insect growth regulator treatments, but may also use an organophosphate insecticide that has a similar mode of action to malathion. These types of treatments typically occur in aquatic areas away from where grasshopper and Mormon cricket treatments would occur. Adulticide treatments include the organophosphate insecticide, malathion and naled, and select pyrethroid insecticides. These types of treatments would occur typically during periods of increased rainfall resulting in mosquito population outbreaks requiring treatment. Typically, grasshopper and Mormon cricket applications occur during periods of lower rainfall resulting in stress to rangeland vegetation that would be more likely to be damaged as a result of grasshopper outbreaks.

The insecticides proposed for use in the grasshopper program are not anticipated to persist in the environment or bioaccumulate. Therefore, a grasshopper outbreak that occurs in an area previously treated for grasshoppers is unlikely to cause an accumulation of insecticides from previous Program treatments.

The Program applies the insecticides in a way that minimizes significant exposure to soil, water, and air. The lack of significant routes of exposure to human health and the environment, along with favorable toxicity profiles for these compounds, suggest cumulative impacts would not occur with their use.

Pesticides occur in surface waters throughout the United States resulting in potentially synergistic or additive effects to aquatic biota (USGS, 2014). Aquatic life benchmark criteria were exceeded 61 percent, 90 percent, and 46 percent of the time by one or more pesticides in agricultural, urban and mixed use watersheds, respectively (Stone et al., 2014). Benchmark criteria are values above which a pesticide residue is expected to be toxic to sensitive aquatic biota. The significant number of water bodies currently with pesticide levels exceeding aquatic life criteria suggests any additional pesticide inputs would cause additional negative cumulative impacts. The addition of potential insecticide residues from grasshopper treatments to those that currently are being measured in surface waters is difficult to quantify due to temporal and spatial variability when insecticide applications would occur. For example, malathion has been detected in surface waters throughout the United States, including States where grasshopper suppression activities may take place (Stone et al., 2014). Malathion has numerous use patterns; however, the Program rarely uses malathion. Since 2006, the Program used malathion only once. This was in 2009 when the Program applied malathion to 1,744 acres of the 68,647 acres that received Program insecticide treatments. The contribution of malathion residues to surface waters from grasshopper applications is expected to be minor. Label restrictions for Program insecticides and Program application buffers from aquatic resources suggest that contributions to surface water would be negligible. Risk would be greatest for aerial applications, which the Program mostly uses; however, applications would not result in residues that would have individual or cumulative impacts to aquatic environments because the Program uses buffers and follows application guidelines to minimize exposure. Other human-caused and natural stressors occur in water bodies making the cumulative impacts of all stressors difficult to quantify.

c. Other Environmental Considerations

1. *Irreversible and Irretrievable Commitment of Resources*

APHIS has been working on various aspects of the grasshopper and Mormon cricket suppression program for over 35 years. This has included research to better understand the use of IPM in managing grasshopper populations, with the product of that work being the publication of the 1996 Grasshopper IPM handbook. Since then APHIS has continued to allocate resources to conduct research to evaluate cost-effective methods for grasshopper suppression that minimize impacts to the environment.

APHIS works with multiple stakeholders regarding the implementation of grasshopper and Mormon cricket suppression activities. This includes cost-sharing to implement various aspects of the Program. The Federal share of these costs varies depending on the activity. Survey and technical assistance involves costs associated with providing staff for technical assistance and conducting surveys. If treatments are warranted, resource costs vary depending on whether treatments occur on Federal or state lands, or private lands. These costs include personnel time, equipment, insecticides and fossil fuel use. Cost sharing on State-managed lands and private lands reduces the amount of resources committed by APHIS to make suppression treatments.

Treatments are made as suppression applications and would not result in eradication of grasshoppers from treated areas, which is not the goal of the Program. Effects to natural resources are reduced by the implementation of measures described in this EIS. Buffer zones near aquatic water bodies and the use of RAATs are examples of measures designed to minimize adverse effects to natural resources.

2. *Environmental Justice*

Federal agencies identify and address the disproportionately high and adverse human health or environmental effects of their proposed activities, as described in Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The USDA has developed Departmental Regulation 5600-2 (USDA, 1997) that provides direction for integrating environmental justice considerations into USDA programs and activities. USDA's goals in implementing EO 12898 are as follows (USDA, 1997):

1. To incorporate environmental justice considerations into USDA's programs and activities and to address environmental justice across mission areas;

2. To identify, prevent, and mitigate, to the greatest extent practicable, disproportionately high and adverse human health or environmental effects of USDA programs and activities on minority and low-income populations; and

3. To provide, to the greatest extent practicable, the opportunity for minority and low-income populations to participate in planning, analysis, and decision making that affects their health or environment, including identification of Program needs and designs.

When planning a site-specific action related to grasshopper or Mormon cricket infestations, APHIS will consider the potential for disproportionately high and adverse human health or environmental impacts of its actions on minority and low-income communities, Tribes, and historical and culturally sensitive sites in a Program area.

3. *Protection of Children*

Federal agencies consider a proposed action's potential effects on children to comply with EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks." This EO requires each Federal agency, consistent with its mission, to identify and assess environmental health and safety risks that may disproportionately affect children and to ensure its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. APHIS has developed agency guidance for its programs to follow to ensure the protection of children (USDA APHIS, 1999).

APHIS grasshopper insecticide treatments are conducted in rural rangeland areas, where agriculture is a primary industry. The areas consist of widely scattered, single, rural dwellings in ranching communities with low population density. The

Program notifies residents within treatment areas, or their designated representatives, prior to proposed operations to reduce the potential for incidental exposure to residents including children. Treatments are conducted primarily on open rangelands where children would not be expected to be present during treatment or to enter should there be any restricted entry period after treatment. The Program also implements mitigation measures beyond label requirements to ensure that no treatments occur within the required buffer zones from structures, such as a 500-foot treatment buffer zone from schools and recreational areas (USDA APHIS, 2016b). Also, Program insecticides are not applied while school buses are operating in the treatment area (USDA APHIS, 2016b).

APHIS' HHERAs evaluated the potential exposure to each insecticide used in the Program and risks associated with these insecticides to residents, including children. The HHERAs for the proposed Program insecticides, located at http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019), suggest that no disproportionate risks to children, as part of the general public, are anticipated.

4. *Tribal Consultation*

Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments," calls for agency communication and collaboration with tribal officials when proposed Federal actions have potential tribal implications. The Archaeological Resources Protection Act of 1979 (16 U.S.C. §§ 470aa-mm), secures the protection of archaeological resources and sites on public and tribal lands.

Prior to the treatment season, Program personnel notify Tribal land managers of the potential for grasshopper and Mormon cricket outbreaks on their lands. Consultation with local Tribal representatives takes place prior to treatment programs to inform fully the Tribes of possible actions APHIS may take on Tribal lands. Letters of request for treatments must be on file from the Tribal government and Bureau of Indian Affairs before grasshopper control activities can begin on reservation land or areas managed for traditional Native American activities.

The potential for impacts that could occur from Program-related activities to cultural and historical sites and artifacts, and cultural events, would be considered in site-specific environmental documents. A Program treatment is of short duration and generally occurs only once in a Program area during the treatment season. Treatments typically do not occur at cultural sites, and drift from a Program treatment at such locations is not expected to adversely affect natural surfaces, such as rock formations and carvings. APHIS would also confer with the appropriate Tribal authority to ensure that the timing and location of a planned

Program treatment does not coincide or conflict with cultural events or observances on Tribal lands.

5. *Fires and Human Health Hazards*

Various compounds are released in smoke during burning in wildland fires, including carbon monoxide (CO), CO_2, nitrous oxides (NOx), sulfur dioxide (SO_2), hydrogen chloride (HCl), aerosols, polynuclear aromatic hydrocarbons (PAH) contained within fine particulate matter (a byproduct of the combustion of organic matter such as wood), aldehydes, and most notably formaldehyde produced from the incomplete combustion of burning biomass (Reisen and Brown, 2009; Burling et al., 2010; Broyles, 2013). Particulate matter, CO, benzene, acrolein, and formaldehyde have been identified as compounds of particular concern in wildland fire smoke (Reinhardt and Ottmar, 2004). Respirable particulates carrying absorbed and condensed toxicants can be inhaled into the deeper recesses of the lungs and can cause inflammation of the lungs, and short-term effects such as cough, shortness of breath, and chest pain (Bytnerowicz et al., 2009). Symptoms of CO exposure from vegetative smoke include headaches, dizziness, nausea, loss of mental acuity, and fatigue (U.S. Department of Labor, 2002). SO_2 exposure causes severe irritation of eyes, skin, upper respiratory tract, and mucous membranes, and can cause bronchoconstriction. SO_2 can damage the airways of humans, and long-term exposure to SO_2 reduces lung volume and its ability for gaseous diffusion (Bytnerowicz et al., 2009).

Many of the naturally occurring products associated with combustion from wildfires may also be present as a result of combustion of Program insecticides that are applied to rangeland. These combustion byproducts will be at lower quantities due to the short half-lives of most of the Program insecticides and their low use rates. Other minor combustion products specific to each insecticide may also be present as a result of combustion from a rangeland fire but these are typically less toxic based on available human health data (http://www.aphis.usda.gov/plant-health/grasshopper (URL last accessed October 21, 2019)). The safety data sheet (SDS) for each insecticide identifies these combustion products for each insecticide as well as recommendations for PPE; much of it similar to what typically is used in fighting wildfires. Material applied in the field will be at a much lower concentration than what would occur in a fire involving a concentrated formulation. All of the Program insecticides are applied at low rates, and with the exception of chlorantraniliprole, they all degrade rapidly under field conditions, further reducing potential exposure to products of insecticide combustion in the event a fire occurs after treatment. Considerations for treatment would also be made in the event that a grasshopper outbreak occurs in proximity to a wildfire because the effectiveness of the insecticide would be less than the wildfire itself.

6. ***Endangered Species Act***

Section 7 of the Endangered Species Act (ESA) and its implementing regulations require Federal agencies to ensure their actions are not likely to jeopardize the continued existence of listed threatened or endangered (listed) species, or result in the destruction or adverse modification of critical habitat.

(1) Potential Effects of Grasshopper Suppression Programs on Threatened and Endangered Species and Critical Habitat

Numerous federally-listed species and areas of designated critical habitat occur within the 17-State area, although not all occur within or near potential grasshopper suppression areas. Grasshopper suppression may pose a risk to listed species and critical habitat without proper mitigation. Direct effects, such as acute toxicity effects, could occur from exposure of species, such as salmonids and other listed fish, birds, amphibians, and invertebrates, to insecticide applications. Indirect effects to listed species, such as loss of prey or loss of plant pollinators, could also occur as a result of exposure to Program insecticides.

(2) Endangered Species Act Consultations with USFWS and NMFS

APHIS considers whether listed species, species proposed for listing, experimental populations, or critical habitat are present in the proposed suppression area. Before treatments are conducted, APHIS contacts the U.S Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) (where applicable) to determine if listed species are present in the suppression area, and whether mitigations or protection measures must be implemented to protect listed species or critical habitat.

National Marine Fisheries Service Consultation

APHIS completed a programmatic Section 7 consultation with NMFS for use of carbaryl, malathion, and diflubenzuron to suppress grasshoppers in the 17-state Program area. The Snake River steelhead (*Oncorhynchus mykiss*), Middle Columbia River steelhead, Upper Columbia River steelhead, Lower Columbia River steelhead, Snake River fall Chinook salmon (*0. tshawytscha*), Snake River spring summer Chinook salmon, Upper Columbia River spring run Chinook salmon, Lower Columbia River Chinook salmon, Sacramento winter-run Chinook salmon, Lower Columbia River coho salmon (*O. kisutch*), and Columbia River chum salmon (*O. keta*) are present in the action area.

To minimize the possibility of insecticides from reaching salmonid habitat, APHIS implements the following protection measures:

- RAATs are used in all areas adjacent to salmonid habitat

- ULV sprays are used, which are between 50 and 66% of the USEPA recommended rate
- Insecticides are not aerially applied in 3,500 foot buffer zones for carbaryl or malathion or in 1,500 foot buffer zones for diflubenzuron along stream corridors
- Insecticides will not be applied when wind speeds exceed 10 miles per hour. APHIS will attempt to avoid insecticide application if the wind is blowing towards salmonid habitat
- Insecticide applications are avoided when precipitation is likely or during temperature inversions

APHIS determined that with the implementation of these measures, the grasshopper suppression program may affect, but is not likely to adversely affect listed salmonids or designated critical habitat in the Program area. NMFS concurred with this determination in a letter dated April 12, 2010. The final biological assessment (May 2010) is included in the administrative record for this EIS. Chlorantraniliprole was not included in the 2010 consultation. However, APHIS will consult with NMFS at the local level if there could be co-occurrence of Program chlorantraniliprole applications and listed salmonids.

U.S. Fish and Wildlife Service

APHIS submitted a programmatic biological assessment and requested consultation with USFWS on March 9, 2015 for use of carbaryl, malathion, diflubenzuron, and chlorantraniliprole for grasshopper suppression in the 17-state Program area.

APHIS proposed chemical-specific application buffers from listed species and their critical habitats, as well as the following operational restrictions. These restrictions will apply to all proposed treatment methods to reduce further insecticide exposure to listed species that could occur in proximity to treatment areas.

- Avoid applications when sustained winds speeds exceed 10 miles per hour
- Use RAATs where listed species are present and adjacent to designated critical habitat
- Avoid applications under conditions where a temperature inversion is possible or when a storm event is imminent

With the incorporation and use of application buffers and other operational procedures, including the restrictions listed above, APHIS anticipates that any impacts associated with the use and fate of Program insecticides will be insignificant and discountable to listed species and their habitats. Based on an assessment of the potential exposure, response, and subsequent risk characterization of Program operations, APHIS concludes that the proposed action is not likely to adversely affect listed species or critical habitat in the Program area. APHIS has requested concurrence from the USFWS on these determinations. The biological assessment (March 2015) is part of the administrative record for this EIS. Until this programmatic Section 7 consultation with USFWS is completed, APHIS will conduct consultations with USFWS field offices at the local level.

7. *Migratory Bird Treaty Act*

The Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703–712) established a Federal prohibition, unless permitted by regulations, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird or any part, nest, or egg of any such bird.

Executive Order 13186 directs Federal agencies taking actions with a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding with the USFWS that promotes the conservation of migratory bird populations. On August 2, 2012, a Memorandum of Understanding between APHIS and the USFWS was signed to facilitate the implementation of this Executive Order.

In accordance with Executive Order 13186, MBTA, APHIS will support the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions. Impacts are minimized as a result of buffers to water, habitat, nesting areas, riparian areas, and the use of RAATs. For any given treatment, only a portion of the environment will be treated, therefore minimizing potential impacts to migratory bird populations.

8. *Bald and Golden Eagle Protection Act*

The Bald and Golden Eagle Protection Act (16 U.S.C. 668–668c) prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who “take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle…[or any golden eagle], alive or dead, or any part, nest, or egg thereof.”

The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.”

During the breeding season, bald eagles are sensitive to a variety of human activities. Grasshopper management activities could cause disturbance of nesting eagles, depending on the duration, noise levels, extent of the area affected by the activity, prior experiences that eagles have with humans, and tolerance of the individual nesting pair (USFWS, 2007). Also, disruptive activities in or near eagle foraging areas can interfere with bald eagle feeding, reducing chances of survival (USFWS, 2007).

No toxic effects are anticipated on eagles as a direct consequence of insecticide treatments. Toxic effects on the principle food source, fish, are not expected because insecticide treatments will not be conducted over rivers or lakes. Buffers protective of aquatic biota are applied to their habitats to ensure that there are no indirect effects from loss of prey.

USFWS has recommended buffer zones from active nests for activities applicable to grasshopper management programs (USFWS, 2007). They are as follows:

- For off-road vehicle use, no buffer is necessary around nest sites outside the breeding season. During the breeding season, do not operate off-road vehicles within 330 feet of the nest. In open areas, where there is increased visibility and exposure to noise, this distance should be extended to 660 feet.
- Avoid operating aircraft within 1,000 feet of the nest during the breeding season, except where eagles have demonstrated tolerance for such activity.

USFWS has provided recommendations for avoiding disturbance at foraging areas and communal roost sites that are applicable to grasshopper management programs (USFWS, 2007). They are as follows:

- Minimize potentially disruptive activities and development in the eagles’ direct flight path between their nest and roost sites and important foraging areas.
- Locate aircraft corridors no closer than 1,000 feet vertical or horizontal distance from communal roost sites.

9. *Additional Species of Concern*

There may be species that are of special concern to land management agencies, the public, or other groups and individuals in proposed treatment areas. For example, the sage grouse is a species of concern to land management agencies. BLM manages much of the best remaining sagebrush habitat for the Greater Sage-Grouse, and has developed land use plans to conserve the habitat (for more information see https://www.blm.gov/programs/fish-and-wildlife/sage-grouse (accessed October 21, 2019)).

Sage grouse are a natural part of rangeland ecosystems in the Western United States. Sage grouse is the largest grouse in North America and is known for the elaborate mating ritual of the males that has been considered one of the continent's great wildlife spectacles (Weidensaul, 2001). Sage grouse have been in a state of decline throughout most of their entire range, with habitat loss being a major factor in their decline.

Sagebrush leaves and buds comprise the vast majority (up to 99%) of sage grouse diet in the winter. Even in the summer, sage grouse live in close association with sagebrush, but succulent forbs and other plants predominate the diet. In the spring, however, sage grouse chicks consume a wide variety of foods, including insects that are necessary for their growth and survival (Johnson and Boyce, 1990; Drut et al., 1994).

Grasshoppers can be diet items for sage grouse chicks. During grasshopper outbreaks when grasshopper densities can be 60 or more per square meter, grasshopper treatments that have a 90 to 95 percent mortality still leave a density of grasshoppers (3 to 6%) that is generally greater than the average density found on rangeland (Schell and Lockwood, 1997). Even though grasshoppers may be less available to sage grouse, behavioral changes (e.g., switching to other diet items or increased foraging time) may help compensate for the lack of grasshoppers (Howe et al., 2000). In addition, with the use of chemical treatment techniques such as RAATs, impacts to the diet of sage grouse chicks should be further reduced.

Although most grasshoppers do not directly damage sagebrush, Pfadt (1994) described that grasshopper nymphs densities of 100 to 3,000 per square yard resulted in the defoliation and death of 11 species of native shrubs, as well as forbs and grasses. Forbs and other rangeland vegetation are important sage grouse diet items, especially for juveniles. It is likely that in outbreak conditions, grasshopper may cause widespread destruction of forbs. In those situations when grasshopper densities exceed the ability of predators to control population size (including immature sage grouse), the remaining grasshoppers represent a competitive threat to the food base of juvenile sage grouse.

A temporary reduction in the available food for immature sage grouse is only one of a multitude of threats facing sage grouse. Fire is a threat to physically destroying sagebrush. Rangeland fires can be a natural event, a land management tool, a result of human carelessness, or even an attempt to control grasshoppers. Regardless of the cause, fire directly removes sagebrush habitat for sage grouse until the sagebrush regrows. Other causes of habitat loss include livestock grazing, human development, and anything that serves to fragment or degrade sagebrush habitat. Permanent habitat losses are a significant threat to sage grouse. Reducing grasshopper numbers in a given area is expected to increase the number of other plants that sage grouse consume in the spring and summer, but is not expected to have significant impacts on sage grouse populations overall.

In conclusion, grasshopper suppression programs reduce grasshoppers and at least some other insects in the treatment area. Both sage grouse adults and chicks are likely to be present in some areas where grasshopper treatments are made, and grasshoppers can be a food item for sage grouse chicks. As indicated in previous sections on impacts to birds, there is low potential that the insecticides APHIS would use to suppress grasshoppers would be toxic to sage grouse, either by direct exposure to the insecticides or indirectly through immature sage grouse eating moribund grasshoppers. Because grasshopper numbers are so high in an outbreak year, treatments would not likely reduce the number of grasshoppers below levels present in a normal year. Should grasshoppers be unavailable in small, localized areas, sage grouse chicks may consume other insects, which sage grouse chicks likely do in years when grasshopper numbers are naturally low. By suppressing grasshoppers, rangeland vegetation is available for use by other species, including sage grouse, and rangeland areas are less susceptible to invasive plants that may be undesirable for sage grouse habitat. Habitat degradation and removal by fire, grazing, and human development present long lasting and serious threats to sage grouse survival, unlike temporary insect density reductions.

APHIS will work with BLM, States, and any other appropriate agencies when grasshopper treatments are proposed in areas where sage grouse are present, or any other species that is known to be of special interest or concern to federal or state agencies or the public. At the time that treatment is proposed, APHIS would consider the various species of concern within a site-specific NEPA document.

10. *Cultural and Historical Resources*

Federal actions must seek to avoid, minimize, and mitigate potential negative impacts to cultural and historic resources as part of compliance with the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act of 1979, and NEPA. Section 106 of the NHPA requires Federal agencies to provide the Advisory Council on Historic Preservation with an opportunity to comment on their findings. See https://www.achp.gov/ for more information on Section 106.

There is the potential for impacts to cultural and historical resources if the proposed treatments occur on or near historic trails or properties. If any proposed actions are at, or adjacent to, the site of a historic trail or property, APHIS will consult with the appropriate landowner, the State Historic Preservation Office, any affected National Trail's administrative office, or other appropriate agencies, to ensure minimal impacts to cultural and historical resources. Chemical treatments will not be applied without the necessary approvals.

11. *NPDES Permits*

USEPA's NPDES permitting program regulates chemical pesticides that leave residues in waters of the United States. USEPA and States issue Pesticide General Permits (PGPs) to offer coverage for pesticide operators. Pesticide applications that are not eligible for coverage under a PGP may need to apply for an individual permit. The Program will consider NPDES when a treatment site is proposed, and will comply with requirements if the Program decides chemically to treat rangelands.

Appendix A. Grasshoppers of Economic Importance in Western Rangeland

Source: (Pfadt, 2002)

Common Name	Scientific Name	Geographical Distribution	Host Plants
Bigheaded grasshopper	*Aulocara ellioti* (Thomas)	From southern Canada to central Mexico	Sedges and grasses. Blue grama, western wheatgrass, needleandthread, thread-leaf sedge, needle leaf sedge, and crested wheatgrass
Clearwinged grasshopper	*Camnula pellucida* (Scudder)	Northern and western US; Canada	Pest of small grains and grasses. Feeds on many species of grasses, including fescues bluegrasses, wheatgrasses, bromes and slender hairgrass
Fourspotted grasshopper	*Phlibostroma quadrimaculatum* (Thomas)	Central western US; southern Canada; Mexico	Shortgrass, mixedgrass, desert, and bunchgrass prairies. Blue grama, buffalograss, buffalograss, needleandthread, western wheatgrass, sand dropseed, sideoats grama, and prairie sandreed
Kiowa grasshopper	*Trachyrhachys kiowa* (Thomas)	Western to mid-Atlantic US; southern Canada; Mexico	Blue grama, forage grasses, sedges, western wheatgrass, needle-andthread, Kentucky bluegrass, threadleaf sedge, needle-leaf sedge, and Penn sedge
Migratory grasshopper	*Melanoplus sanguinipes* (Fabricius)	US and most of Canada	Pest of crops and grasslands. Forbs and grasses, alfalfa, barley, clover, corn, oats, ornamentals, wheat
Mormon cricket	*Anabrus simplex* Haldeman	Northwestern US; southern Canada	More than 400 species of plants, preferring succulent forbs. Preferred forbs include milkvetches, penstemon, arrowleaf balsamroot, dandelion, and several. Saltbush and sagebrush
Obscure grasshopper	*Opeia obscura* (Thomas)	Northwestern and southwestern US; Mexico	Blue grama, needleandthread, buffalograss, sand dropseed, little bluestem, and western wheatgrass
Redlegged grasshopper	*Melanoplus femurrubrum* (DeGeer)	US; Canada; Mexico	Crop pest- alfalfa, clover, soybeans, and small grains, corn tobacco, vegetables. Forbs and grasses, legumes and composites
Spottedwing grasshopper	*Cordillacris occipitalis* (Thomas)	Western US; southern Canada	Rangeland grasses

Striped grasshopper	*Amphitornus coloradus* (Thomas)	Western US; southern Canada; Mexico	Grasses, sedges
Twostriped slantfaced grasshopper	*Mermiria bivitatta* (Serville)	Central western states east to mid-Atlantic; Mexico	Forage grasses, tall grasses
Twostriped grasshopper	*Melanoplus bivittatus* (Say)	Most of US; Canada	Major crop pest to small grains, alfalfa, and corn. Polyphagous. Cultivated plants, mustards, plaintain, legumes, and composites
Velvetstriped grasshopper	*Eritettex simplex* (Scudder)	North central western states east to mid-Atlantic	Grasses, sedges
Whitecrossed grasshopper	*Aulocara femoratum* Scudder	Western US; western Mexico	Grasses, sedges
Whitewhiskered grasshopper	*Ageneotettix deorum* (Scudder)	Western and Midwestern US; western Mexico; southwestern Canada	Grasses, sedges

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Appendix D. APHIS response to public comments on the draft EIS

USDA APHIS received 19 public responses to publication of the draft EIS. General comments were received from the public supporting and opposing efforts by USDA APHIS to suppress grasshopper and Mormon cricket populations. Public comments were received from the County Duchesne Commission, two State agencies (Nevada Department of Agriculture and the Wyoming Game and Fish Agency), two Federal agencies (U.S. Environmental Protection Agency (EPA) and the Department of the Interior (DOI)), the registrants for carbaryl, malathion, and chlorantraniliprole; five stakeholder groups including the Center for Biological Diversity, South Dakota Stock Growers Association, Xerces Society, Pollinator Stewardship Council and the Association of National Grasslands; and interested public citizens. Comments similar in nature were grouped under one response. Comments that were editorial in nature or requested additional citations are not addressed in the appendix but were incorporated into the final EIS, where appropriate.

Comment 1

USDA APHIS received four comments proposing the use of biological control methods to control grasshopper and Mormon cricket populations.

USDA APHIS discussed the potential for the use of biological control methods to treat grasshopper and Mormon cricket populations in the draft EIS. The use of biological control methods was not considered in the preferred alternative analysis because there are currently no biological control products registered for use in the United States. USDA APHIS has evaluated the use of biological control methods in experimental applications; however, they have not proven to be effective and consistent in their control of grasshopper and Mormon cricket outbreaks. USDA APHIS will continue to evaluate other control measures, including biological control agents, and will incorporate those measures into the program once shown to be effective and registered for use in the United States.

Comment 2

USDA APHIS received one comment that the EIS should consider the effects that suppression have on species that provide natural biocontrol against grasshoppers, including spiders.

Impacts to natural biocontrol agents are discussed throughout the document. First, APHIS discusses impacts in general terms of "non-targets" in the section on baits versus sprays on page 33 of the draft EIS. The main point is that the baits affect fewer non-targets, which include natural biocontrol agents. APHIS also looked at the impacts of the use of RAATs on non-targets, and specifically *mentions predators and parasites of grasshoppers, as well as beneficial grasshoppers (page 34 of draft EIS).*

APHIS discussed a study in the draft EIS that specifically discussed impacts of potential chemical treatments on spiders (page 56 of the draft EIS, under section on diflubenzuron). APHIS noted there was a significant decrease in spider populations in the study, but also made note that the author questioned the spider analysis because the untreated populations also dropped dramatically during the study. APHIS also discussed impacts on arthropods, a phylum that includes spiders. Impacts of carbaryl on arthropods on pages 41 and 45 and diflubenzuron on pages 55 and 56 of the draft EIS.

There is not a separate section on biocontrol agents, rather the document refers to them as potential grasshopper predators and discussions are organized within the wildlife sections under each chemical. Impacts from each chemical on food sources (including grasshoppers) of mammals, birds, and terrestrial invertebrates, are covered on page 41 for carbaryl, 51 for diflubenzuron, 61 for malathion, and 74 for chlorantraniliprole in the draft EIS.

Lastly, impacts to sage grouse, a predator of grasshoppers, is discussed in a separate section under "Additional Species of Concern". The section discusses how the chicks consume insects, which are necessary for their growth and survival (page 91 of draft EIS). APHIS acknowledges that, "with the use of chemical treatment techniques such as RAATs, impacts to the diet of sage grouse chicks should be further reduced" (page 91 of draft EIS).

Comment 3

USDA APHIS received several comments from EPA Office of Pesticide Programs (OPP) specific to the insecticides used in the program. Many of the recommendations were to include updated information available from EPA OPP.

USDA APHIS appreciates the additional references and information that OPP provided in response to the draft EIS. Many of the references are currently cited in the individual chemical human health and ecological risk assessments that were referenced in the draft EIS and available at the USDA APHIS website. New information provided by OPP was added in the human health and ecological risk assessments and referenced in the final EIS, where appropriate.

Comment 4

One commenter expressed concern that USDA APHIS may violate the Endangered Species Act (ESA) with the application of insecticides in proximity to Federally-listed species.

USDA APHIS complies with the ESA under Section 7 of the Act, which requires all Federal agencies to consult with the Fish and Wildlife Service (FWS) and

National Marine Fisheries Service (NMFS). USDA APHIS complies with the ESA for activities related to the grasshopper and Mormon cricket suppression program, and considers the potential impacts to Federally-listed species through either Regional or State level consultations with the FWS and NMFS. This was discussed on page 87 of the draft EIS.

Comment 5

One commenter indicated USDA APHIS failed to disclose and analyze the range of rare, sensitive, threatened and endangered species and ecological areas and failed to complete programmatic consultation with the FWS.

USDA APHIS must comply with all ESA requirements. If APHIS is unable to come to a determination that the action will not affect endangered or threatened species and/or their critical habitats, the action cannot be taken without first consulting. The draft EIS is programmatic in nature, so treatments are not currently taking place under this EIS.

As stated on page 87 of the draft EIS, "Numerous federally-listed species and areas of designated critical habitat occur within the 17-State area, although not all occur within or near potential grasshopper suppression areas. Grasshopper suppression may pose a risk to listed species and critical habitat without proper mitigation." The draft EIS also indicates that APHIS will contact U.S. Fish and Wildlife Service or the National Marine Fisheries Service before treatments, to determine if listed species are present in the suppression area, and whether mitigations or protection measures must be implemented to protect listed species or critical habitat (page 87 of draft EIS).

Completed programmatic consultation with NMFS, and subsequent protective measures, are outlined on page 87 and 88 of the draft EIS. APHIS determined that with implementation of protective measures, the grasshopper program may affect, but is not likely to adversely affect listed salmonids or designated critical habitat in the proposed Program area. NMFS concurred with this determination in 2010. Chlorantraniliprole was not included in the 2010 consultation. However, APHIS indicated in the EIS that they will consult with NMFS if there is co-occurrence of the Program's treatment with proposed chlorantraniliprole use and listed salmonids. This would happen prior to treatment with any Program pesticides.

APHIS has submitted a programmatic biological assessment and requested consultation with the FWS on March 9, 2015 for use of carbaryl, malathion, diflubenzuron, and chlorantraniliprole for grasshopper suppression in the 17-state Program area (page 88 of draft EIS). APHIS concluded that the Program actions are not likely to adversely affect listed or critical habitat in the Program area. APHIS requested concurrence from the FWS (page 89 of draft EIS). The FWS has yet to concur with our findings however, both agencies are currently cooperating to complete the programmatic biological assessment. The intent of *the programmatic biological assessment is to provide guidance to FWS and APHIS field offices regarding protection measures for listed species. Until the programmatic Section 7 consultation with the FWS is completed, APHIS will continue to conduct consultations with the FWS field offices at the local level (page 89 of draft EIS). Once the programmatic consultation is complete APHIS will continue to work closely with the FWS field offices regarding species locations and other information prior to making any Program treatments.*

Comment 6

One commenter expressed concerns regarding insecticide resistance in grasshopper and Mormon cricket populations that are treated with Program insecticides.

USDA APHIS makes one application per season using one of four insecticide options. The application rates typically used are much less than the maximum allowed on the label for each product because they are typically applied as a reduced area and agent treatment (RAAT). The RAAT technique uses either reduced rates, alternating swaths, or both for suppression treatments. The proposed application methods used in the program reduce the selection pressure for resistance to the proposed insecticides. Concerns regarding insecticide resistance were addressed in the cumulative impact section of the draft EIS.

Comment 7

The DOI expressed concern regarding the human health impacts related to inhalation risk to firefighters fighting wildfires where carbaryl treatments have occurred.

USDA APHIS provided a qualitative analysis regarding the potential impacts to wildfire firefighters for each of the proposed chemicals in the program. USDA APHIS has updated the final EIS and the carbaryl human health and ecological risk assessment to quantify the potential inhalation risk to wildfire firefighters from carbaryl and known pyrolysis products. In summary, USDA APHIS quantified risk to wildfire firefighters assuming a 20- and 1,700-foot mixing height in inhalation exposures to carbaryl and its associated pyrolysis products. These exposure scenarios were determined using maximum and RAAT carbaryl rates that were compared to available EPA OPP or Occupational Safety and Health Administration safety levels for carbaryl and associated pyrolysis products, where available. Exposures assumed no degradation of carbaryl in the field and no removal by grasshoppers and Mormon crickets. The concentrations of degradates that could occur in the atmosphere were based on 100% conversion from carbaryl to a specific pyrolysis product unless the rate was previously reported (ex. less than 1% of the total amount of applied carbaryl degrades to methyl isocyanate). Estimates of risk were below levels of concern for carbaryl and its associated pyrolysis products under a 1,700-foot mixing height scenario *using full and RAAT rates. Estimates of risk were also below levels of concern for carbaryl and pyrolysis products under the 20-foot mixing height scenario with the exception of carbaryl and methyl isocyanate under the full APHIS rate. Exposure assumptions under the 20-foot mixing height are very conservative and do not demonstrate actual risk under field conditions. Program applications are typically made using RAAT rates and the exposure assessment assumed no degradation of carbaryl or removal by grasshoppers or Mormon crickets, which would occur under typical use.*

Comment 8

A commenter expressed concern that the draft EIS describes the tiering of Environmental Assessments (EA) to the EIS as "fragmenting" the potential impacts of the program.

USDA APHIS prepared a programmatic draft EIS to evaluate the potential impacts to the human environment. USDA APHIS recognized the need for an EIS due to the large geographic area that the Program covers over 17 Western States. The intent of the programmatic EIS is to identify any impacts that may occur over the entire 17 Western States from each of the proposed alternatives. The tiering of a State-specific EA to the EIS allows USDA APHIS to incorporate the findings of the EIS into the analysis of an EA and address any local issues not covered in the programmatic EIS.

Comment 9

A commenter suggested that the Program should separate the analysis for controlling grasshoppers from controlling Mormon crickets due to differences in their biology and taxonomy.

USDA APHIS recognizes that grasshoppers and Mormon crickets occupy different taxonomic groupings. The two groups also have specific niches that they occupy; however, many of the control measures, but not all, are effective for both groups of insects. USDA APHIS selects a control method based on site conditions that includes the life stage and pest species and will provide the most effective level of suppression. This is discussed in more detail under the Purpose and Need section of the draft EIS.

Comment 10

One commenter stated that the no suppression alternative would result in increased insecticide use at higher rates and should be noted in the EIS.

USDA APHIS agrees that a lack of an APHIS suppression program could result in increased insecticide use. This was discussed in the Environmental Consequences section of the draft EIS under the no suppression alternative. A no suppression program would result in the use of other insecticides that may pose a *greater risk than those used in the USDA APHIS program. Environmental loading would also increase where applicators may not use RAAT treatments and look for a higher level of control beyond suppression.*

Comment 11

A comment was received stating that malathion should only be used on lands adjacent to private lands and only as a last resort for large outbreaks.

USDA APHIS currently uses malathion in applications where adult populations have reached levels requiring immediate treatment to protect rangeland and reduce the potential for infestation of adjacent crops. Historical malathion use is negligible in the Program with the preferred method of treatment being either diflubenzuron or carbaryl in greater than 99% of the treatments. When APHIS malathion treatments have occurred, they are applied at lower than labelled rates. The emphasis in the Program is to survey and treat any area prior to adult populations reaching levels that would require malathion treatment. Evidence for this approach is in the low frequency of malathion use in the Program; however, the Program requires flexibility to make treatments based on site-specific conditions that may warrant malathion use.

Comment 12

The DOI recommended the Program contact the National Trails System point-of-contact should Program treatments occur near the National Trails System.

USDA APHIS agrees that in the event that treatments would occur in proximity to a national trail that the appropriate contact should be made within DOI. Reference to making contact for affected administrators managing lands under the National Trails System were added to the final EIS.

Comment 13

A comment was received that recommended the use of carbaryl bait treatments versus spray treatments as a means to protect non-target wildlife, including Federally-listed species.

USDA APHIS selects treatment options based on the pest species requiring a suppression treatment and other site-specific conditions. Carbaryl bait applications are more effective against Mormon crickets and some, but not all, grasshopper species. Site conditions and the pest species dictate the most effective suppression treatment. USDA APHIS consults with the FWS and NMFS regarding all use patterns for each insecticide to ensure protection of Federally-listed species.

Comment 14

The DOI recommended adding the Bureau of Land Management (BLM) Instruction Memorandum (2016-115) to the section in the draft EIS that discusses other additional species of concern, and in particular, protection of sage grouse.

USDA APHIS has added the requested reference to the final EIS in addition to the other BLM resources that were cited in the draft EIS regarding protection of sage grouse.

Comment 15

USDA APHIS received three comments indicating that it failed to assess a reasonable range of alternatives.

Preventative measures have the potential to keep population numbers of grasshoppers low, and are collectively referred to in the EIS as integrated pest management (IPM). IPM for grasshoppers includes biological control, chemical control, rangeland and population dynamics, and decision support tools. "Federal and State land management agencies, State agriculture departments, and private groups or individuals may carry out a variety of preventative IPM strategies that may reduce the potential for grasshopper outbreaks. Some of these activities include grazing management practices, cultural and mechanical methods, and prescribe-burning of rangeland areas..." (page 31 of draft EIS). These actions are and should continue to be considered by agencies as part of proper land management. However, most IPM actions are not managed by APHIS and are outside the scope of this document.

A Memorandum of Understanding between land management agencies, i.e., the Department of Interior's Bureau of Indian Affairs and Bureau of Land Management, and USDA's Forest Service, indicates that while APHIS provides technical expertise, namely advice, regarding grasshopper management actions, the responsibility for implementing most land management practices, including IPM measures, lies with other Federal (i.e., BIA, BLM, and USDA's FS), State, and private land managers (page 32 of EIS).

The scope of the document is on the actions APHIS may consider after making a determination whether treatments are warranted. Treatments may be needed when land management practices are not implemented or are not effective and a potentially economically significant outbreak has occurred. "Despite the best land management efforts to prevent outbreaks, grasshopper populations may build to levels of economic infestation where direct intervention may be the most viable option to suppress them" (page 6 of draft EIS). A key component of the scope of this EIS is when rapid and effective assistance is potentially necessary (page 7 of draft EIS).

Comment 16

USDA APHIS received one comment that it failed to analyze cumulative or synergistic impacts of various other chemical treatments in the area, i.e., widespread mosquito and malathion spraying; livestock treatments; crop treatments; and boll weevil, fruit fly, gypsy moth, and invasive plant treatments. Human and environmental health, as well as impacts to biological control programs, were not analyzed.

USDA APHIS discussed the potential of overlapping chemical treatments in the areas where outbreaks of grasshoppers have occurred or could occur in the future in the cumulative impacts section of the draft EIS, from page 79 to 83. APHIS mentioned the boll weevil, fruit fly, and gypsy moth programs and how overlap of treatments may occur. APHIS discussed the uncertainty in knowing where pests may occur and what new pests may be detected in the future, and therefore, what types of treatments may occur in any given area. While a general analysis of potential cumulative impacts is appropriate in a programmatic NEPA document and was provided, potential cumulative impacts can be addressed in a site-specific EA (as indicated on page 82 of the draft EIS).

APHIS addressed the need to coordinate treatments between pest management programs so that impacts, such as impacts to biological control agents released to manage weeds, could be minimized. APHIS made the following conclusions regarding cumulative impacts: it is unlikely there would be significant overlap between APHIS programs and the grasshopper program and coordinated treatments would mitigate impacts if there is ever overlap; current label and mitigations minimize significant exposure of soil, water, and air to Program insecticides; grasshopper chemical treatments are not expected to persist or bioaccumulate in the environment; and, there is a lack of significant routes of exposure (page 82 to 83 of draft EIS). That said, a site-specific EA would further analyze potential cumulative and synergistic issues based on information specific to the proposed treatment area.

Comment 17

USDA APHIS received one comment indicating they failed to provide an adequate project area description.

The potential project area is rangeland within any of the 17 states listed in the draft EIS (i.e., Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming). Because the potential project area is an extremely large area, the description has to be general in the programmatic EIS. Additional descriptions of the area's conditions were included in chapter 3 with the potential impacts, "Current conditions of the human environment…in which the grasshopper suppression may take place are also included in this chapter" (page 30 of draft EIS). Current conditions were *descriptions of potential baseline conditions that could be impacted by chemical treatment.*

The proposed action area is defined in a site-specific environmental assessment that is prepared by each state that is part of the Program.

Comment 18

USDA APHIS received a request for the agency to explain why they would use full label rates.

Full label rates are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), approved for use by USEPA and States. Full label rates establish a baseline in the draft EIS to compare RAATs. If used at all, it would be a rare occurrence. RAATs is the preferred alternative and gives APHIS the ability to treat at lower rates, lowering costs, while conserving grasshopper predators and parasites in the untreated swaths (page 5 of draft EIS). Historical data for the Program shows that RAATs are the overwhelmingly preferred treatment option for any treatment. Use data between 2006 and 2017 show that of the total acreage treated during that time by the Program, greater than 99% was made using RAATs. In certain cases, a full APHIS rate was used when grasshopper densities were extremely high posing a threat to adjacent crops and rangeland. The APHIS full rates are less than the maximum rate allowed on the label. The infrequent use of full APHIS rates may be due to monitoring and survey work that APHIS and its cooperators conduct throughout the 17 Western states. Survey and monitoring allow for early detection of grasshopper populations and management to minimize extremely large outbreaks. Survey work has also allowed APHIS to make treatments to immature grasshopper stages, which is reflected in the use data where greater than 93% of the total treatment acreage is made using diflubenzuron. The mode of action of diflubenzuron makes it effective primarily on immature stages of grasshoppers.

Comment 19

Two commenters found USDA APHIS provided inadequate description of risk mitigations and RAATs (inadequate guidance on the amount of land that must go untreated); 95% the labelled rate could be used and it could still be called RAATs.

RAATs is discussed in numerous places throughout the document. A quick explanation is found on pages 5, 17, and 18 in the draft EIS. A more in-depth discussion is on pages 23 and 25, with potential impacts of using RAATs on page 34 and 35 in the draft EIS. APHIS finds this to be a reasonable and adequate description of the technique in a programmatic NEPA document. However, should the reader like to learn more, please see the following website, https://www.sidney.ars.usda.gov/grasshopper/Research/lockwood.htm.

RAATs can decrease the rate of insecticide applied by either using a lower insecticide application rate, decreasing the deposition of insecticide applied by alternating one or more treatment swaths, or applying both options simultaneously. Table 2-1 on page 24 of the draft EIS provides full and RAAT rates used in the APHIS Program. For example, carbaryl spray applied in a conventional matter would be at a rate of 0.50 lb/acre, a total volume of 32 fl oz per acre. Under RAATs, carbaryl would be applied at 0.25 lb/acre, total volume would be half of the conventional rate. Applying 95% of the labeled rate does not constitute a RAAT rate in the APHIS program as explained in the various pages listed above or in table 2-1. In the case of carbaryl spray treatments, the rate would be either 0.50 lb ai/ac using a full treatment rate or at a RAAT rate which is 0.25 lb ai/ac.

In addition to the label restrictions and requirements regarding their use, the Program has several other means to reduce exposure of Program insecticides to human health and the environment. Baits are a mitigation measure that could be applied (page 32-34 of draft EIS). A section titled "Additional Treatment Requirements" describes additional mitigations. All aircraft must have a positive on/off system that will prevent leaks from the nozzles and a positive emergency shutoff valve between the tank and the pump. Whenever possible, applicators must avoid aerial ferrying and turnaround routes over water bodies and sensitive habitats, reducing the risk of accidental release of insecticides into aquatic habitats and other sensitive habitats. Wind conditions, and ground and air temperatures must be monitored during application. Treatment buffers have also been established around water bodies. See pages 35–36 of draft EIS for more information.

Comment 20

USDA APHIS received one comment stating that the carbaryl risk assessment is misleading and that APHIS must convey to the public that workers will be put at risk by the use of carbaryl and justify why this risk is acceptable in light of alternatives that are available.

The draft EIS indicates the potential human risks of carbaryl use, i.e., cholinesterase inhibition resulting in nausea, headaches, dizziness, anxiety, and mental confusion, as well as convulsions, coma, and respiratory depression at high levels of exposure (page 47 of draft EIS). The EIS also notes that USEPA classifies the chemical as likely to be carcinogenic based on vascular tumors in mice (page 47 of draft EIS).

The EIS stresses that, when following label directions, the proposed mitigated uses of carbaryl will reduce potential exposures to humans. One important mitigation of using carbaryl is the use of personal protective equipment, as listed on the product labels. Re-entry limitations and restrictions on how often carbaryl can be applied a season (only once), will also keep workers safe (page 48 of draft

EIS). Additionally, carbaryl baits are considered to be less of a risk to human health (page 47 of draft EIS).

As stated in the draft carbaryl risk assessment APHIS made very conservative assumptions in estimating risk to workers. APHIS did identify some risk to workers who apply aerial liquid broadcast applications. APHIS' statement on a conservative approach in the draft human health risk assessment is based on overestimation of non-cancer and cancer risks using several assumptions including:

- *Use of the oral acute toxicity value for the potential dermal and inhalation exposure for workers' non-cancer risks;*
- *Use of the acute exposure instead of lifetime exposure for workers' cancer risks; and*
- *Assume the treated area is 10,000 acres per day for the mixing and loading using aerial application. This value was derived using actual treated acres for the program of 16,963 acres over 2 days in 2016 (8481.5 acres per day). Typical treatment acres are less than 2,500 acres per day.*

Below is a detailed discussion on the non-cancer and cancer risks for carbaryl using updated assumptions that more accurately describe potential risks to workers.

<u>Non-cancer risks:</u>
A hazard quotient of 1 was estimated in the draft human health risk assessment for the closed loading system under the occasional 10,000 acres scenario is considered to be protective because the oral toxicity value used for the potential dermal and inhalation routes for occupational exposure results in over-estimation of risks. The draft risk assessment used an acute oral reference dose (RfD) of 0.01 mg/kg/day to estimate the non-cancer risks for the dermal and inhalation exposure routes because USEPA did not establish a RfD for dermal or inhalation routes. Using an RfD based on dermal and inhalation exposure is more appropriate to determine non-cancer risks associated with these occupational exposure routes.

Using the USEPA method to estimate a RfD (i.e. a NOAEL/uncertainty factor) (USEPA, 2017a), APHIS calculated an acute dermal reference dose of 0.086 mg/kg/day, which is an estimated human point of departure (POD) of 86 mg/kg divided by 100 (10x for interspecies extrapolation, 10x for intraspecies extrapolation, and 1x for Food Quality Safety Act (FQPA) safety factor) for dermal exposure. APHIS also calculated an acute inhalation reference dose of 0.033 mg/kg/day, which is the POD of 1.0 mg/kg divided by 30 (3x for interspecies extrapolation, 10x for intraspecies extrapolation, and 1x for FQPA safety factor) for inhalation exposure. APHIS revised the non-cancer effect estimations with these toxicity values for dermal and inhalation exposure.

The revised risk estimations for the three exposure scenarios are summarized in table 1. Under the mixing and loading exposure scenario for workers, the revised risk estimates show that the dermal and inhalation combined HQ values for a conventional application rate (maximum), a RAAT application rate (average), and a closed loading system were 3, 2, and 0.8, respectively. These risk estimations for the maximum and average scenarios use dermal and inhalation unit exposures for a single layer with gloves and no respirator protection. The risk estimation for a closed loading system uses dermal and inhalation unit exposures for an engineering control using a closed loading system. A conventional application rate was used for the closed loading system risk estimation. The HQ for the mixing and loading with a closed system exposure is below the USEPA's level of concern (HQ of 1) indicating no concerns for adverse health risks. However, the HQs of 3 and 2 for the mixing and loading without engineering control (a closed system) exceed 1, indicating potential risk. As stated in the draft risk assessment "Because of the adverse health concerns from the estimated risk associated with the dermal exposure (maximum and average) with the single layer with gloves protection for workers under the mixing and loading exposure scenario, an engineering control with a closed loading system protection should be used during mixing and loading if the treated area is 10,000 acre per day." USEPA reduces PPE requirements when engineering controls (i.e. a closed loading/application system) are used (USEPA, 2017b).

Table 1. Revised risk estimates for three exposure scenarios

	Maximum	Average	Closed Loading System	USEPA Level of Concern
Mixing and Loading Scenario				
HQ	**3**	**2**	0.8	1
MOE dermal	**37**	**73**	160	100
MOE inhalation	73	146	193	30
Aggregated risk index	**0.3**	**0.6**	1.3	1
Cancer Risk	4×10^{-6}	2×10^{-6}	9.5×10^{-7}	10^{-4} to 10^{-6}
Ground Application Scenario				
HQ	0.1	0.06	-	1
MOE dermal	2780	6949	-	100
MOE inhalation	267	667	-	30
Aggregated risk index	6.7	16.8	-	1
Cancer Risk	2×10^{-7}	7×10^{-8}	-	10^{-4} to 10^{-6}
Aerial Application Scenario				
HQ	0.2	0.08	-	1
MOE dermal	662	1323	-	100
MOE inhalation	3265	6531	-	30
Aggregated risk index	6.2	12.5	-	1
Cancer Risk	2×10^{-7}	1×10^{-7}	-	10^{-4} to 10^{-6}

Note: Bold – exceeded the USEPA level of concern - Not applicable

Under the ground application exposure scenario, the revised risk estimates for workers show that the dermal and inhalation combined HQ values for a conventional application rate and a RAAT application rate were 0.1 and 0.06, respectively. Under the aerial application exposure scenario, the revised risk estimates for workers show that the dermal and inhalation combined HQ values for a conventional application rate and a RAAT application rate were 0.2 and 0.08, respectively. These HQs are below the USEPA's level of concern (HQ of 1) indicating a lack of risk from ground and aerial applications.

The USEPA Office of Pesticide Programs uses a margin of exposure (MOE) instead of a hazard quotient to estimate risk to human health. A MOE is a ratio of the toxicological endpoint (usually a NOAEL) to exposure that characterizes risk. A MOE is calculated using a dermal or an inhalation POD divided by a dermal or an inhalation dose. A MOE is then compared to a route-specific level of concern (LOC) to determine whether the calculated risk is a health concern. If the MOE is greater than the LOC there is a presumption of no risk to human health through that exposure pathway. The LOC for carbaryl dermal exposure to adults is 100 (10X for interspecies extrapolation, 10X for intraspecies extrapolation, and 1X for FQPA safety factor). The LOC for inhalation exposure is 30 (3X for interspecies extrapolation, 10X for intraspecies extrapolation, and 1X for FQPA safety factor).

APHIS estimated MOEs and compared those values to USEPA's levels of concern for three carbaryl exposure scenarios (table 1). Under this approach, the risk to occupational workers for each exposure route is the daily dermal and inhalation dose received by occupational workers compared to the appropriate POD (i.e., NOAEL). The estimated MOEs under the mixing and loading exposure scenario for a conventional application rate, a RAAT application rate, and a closed loading system were 37, 73, and 160, respectively for a dermal route and 73, 146, and 193, respectively for an inhalation route. A total aggregated risk index (ARI) was calculated since the LOCs for dermal exposure (100) and inhalation exposure (30) are different. The calculated ARIs for the maximum, average, and a closed loading system exposures are 0.3, 0.6, and 1.3, respectively. The USEPA's target ARI is 1. The calculated ARI of 1.3 for the exposure with a closed loading system is higher than 1 indicating that there is minimal risk of adverse health effects. The calculated ARI values of 0.3 and 0.6 for exposures without a closed loading system are less than 1 indicating risk estimates of concern. The estimated MOEs under the ground application exposure scenario for a conventional application rate, and a RAAT application rate were 2780 and 6949, respectively for a dermal route and 267 and 667, respectively for an inhalation route. The calculated ARI values for the maximum and average exposures are 6.7 and 16.8, respectively. The estimated MOEs under the aerial application exposure scenario for a conventional application rate and a RAAT application rate were 662 and 1323, respectively for a dermal route and 3265 and 6531, respectively for an inhalation route. The calculated ARIs for the maximum and average exposures of 6.2 and 12.5 are higher than 1 indicating that there is minimal risk to applicators.

With the exception of exposures from the mixing and loading without an engineering control (a closed loading system), the estimated MOEs or calculated ARIs from other exposures are higher than the USEPA's levels of concern of 100 (dermal) and 30 (inhalation) or a target ARI of 1 indicating that there is minimal risk for adverse health effects. The MOE evaluation results are consistent with the HQ evaluation results.

Cancer Risks:
For cancer risks, the acceptable cancer risk range of 10^{-4} and 10^{-6} is based on the OPP Cancer Worker Risk Policy (USEPA, 2000c). The cancer risks estimated in the APHIS draft human health risk assessment used the same acute exposure time as non-cancer effects rather than lifetime exposure to carbaryl. As a result, the cancer risk calculations are over-estimations of risks. Under a lifetime average daily dose exposure, the cancer risks from the mixing and loading exposure scenario for a conventional application rate, a RAAT application rate, and a closed loading system were 4×10^{-6}, 2×10^{-6}, and 9.5×10^{-7}, respectively. The cancer risks from the ground application exposure scenario for a conventional application rate and a RAAT application rate were 2×10^{-7} and 7×10^{-8}, respectively. The cancer risks from the aerial application exposure scenario for a conventional application rate and a RAAT application rate were 2×10^{-7} and 1×10^{-7}, respectively. The highest cancer risks (4×10^{-6} and 2×10^{-6}) are from mixing and loading without a closed loading system. The other cancer risks are less than 10^{-6}. These cancer risks are within the acceptable risk range of 10^{-4} and 10^{-6}, or less, indicating no concerns for adverse health risk for workers.

The carbaryl human health and ecological risk assessment was updated to reflect the above proposed changes.

Comment 21

USDA APHIS received one comment that APHIS did not address the economic damage and loss of pollination services that chemical treatments can cause the honey bee industry. Additionally, the commenter indicated that APHIS cannot rely on State Pollinator Plans or state registrations of beekeepers and the draft EIS did not address in the 48 hour notification of beekeepers where they would move their bees.

While impacts to honey bees were not discussed in terms of monetary loss, potential impacts on pollinators, including honey bees, were analyzed in the Potential Impacts of Insecticide Application section. Potential impacts from carbaryl on pollinators are on page 45 and 46; diflubenzuron is on page 57 and 58; malathion is on page 65; and, chlorantraniliprole is on page 76 of the draft EIS. Table 3-4 summarizes potential risks from each chemical to pollinators, with risks from malathion being of greatest concern. Risks from all chemicals can be reduced through mitigations such as buffers and RAATs.

Page 13 of the draft EIS discusses surveys. APHIS may conduct surveys when outbreaks occur to determine whether chemical treatments should be considered. Besides collecting information on land ownership, rangeland conditions, APHIS also is surveying for sensitive sites. Among other things, sensitive sites include apiaries.

Notifying beekeepers, and doing so 48 hours prior to treatment, or having a treatment buffer around beehives, are means to mitigate impacts on hives. APHIS understands that it may prove difficult to locate all hives that are in the treatment area and is aware that states can vary in their registration requirements. While on January 1, 2019, it became unlawful in California to maintain an unregistered apiary, APHIS understands that this is an exception rather than the rule. If apiary location data is accessible in the proposed treatment area, or if apiaries are located during a survey, notifying beekeepers within 48 hours of treatment could provide beekeepers with options should they want to move their hives, and should they have the ability to move their hives further from a treatment area. APHIS understands this option may not be practical for all hives. That said, any mitigations required by EPA on the insecticide product label, including those that are meant to protect honeybees, such as including a treatment buffer around the hives, must be followed or APHIS will not be able to apply the insecticide.

Mitigations such as not applying to rangeland when plants visited by bees are in bloom, treatment buffers, and RAATs can be utilized to protect honeybees. RAATs and its potential to decrease impacts on pollinators is discussed throughout the document. Table 2-1 is a summary of the reduced application rates that will be applied for each chemical under RAATs.

Prior to making treatments, APHIS coordinates with local officials and landowners and follows state requirements in place for protecting honeybees. APHIS collects information on the prevalence of apiaries in or near the treatment area as well as when and what plants bees may visit when treatment may occur.

Comment 22

USDA APHIS received one comment that the valuable ecosystem services that grasshoppers provide in grasslands must be taken in to account in the EIS.

USDA APHIS agrees with the commenter that the vast majority of grasshoppers are not pests and form a critical part of the food web, as indicated in the draft EIS on page 5. Additionally, in the environmental impact section (chapter 3), potential impacts to non-targets (including grasshoppers) are addressed for each proposed chemical. Potential impacts on grasshoppers (appearing under the section title "terrestrial invertebrates"), are discussed for each chemical on the following pages of the draft EIS: page 45 for carbaryl, page 55 for diflubenzuron, page 65 for malathion, page 76 for chlorantraniliprole.

Should APHIS consider chemical treatment of an area, the RAATs strategy is most effective at limiting insecticide exposure of valuable grasshoppers, because the treatment area may be reduced and less insecticide is applied per treated acre. "Insecticides suppress grasshoppers within treated swaths, yet RAATs reduces cost and conserves non-target biological resources (including predators and parasites of grasshoppers, as well as beneficial grasshoppers) in untreated areas…With less area being treated, more beneficial grasshoppers and pollinators survive treatment" (page 34 of draft EIS). As indicated in the draft EIS, the RAATs strategy is the most common application method for all Program insecticides.

Comment 23

USDA APHIS received one comment that the final EIS must substantiate claims of harm posed by grasshoppers in rangelands; assertions made are based on a single study, Latchinsky, et al., 2011, in Hawaii. While grasshopper outbreaks in western rangelands can be damaging to grazing in the short-term, the EIS cites no relevant studies that examine the length of time that grasshopper damage lasts.

The draft EIS discusses potential harm posed by grasshoppers to rangelands in the section titled, "Why is there a need to manage this pest?" (page 6 of the draft EIS) and "Damage Caused by Grasshoppers" (page 11 of draft EIS). The economic damage, the manner in which pest grasshoppers eat grass, damage to grazing livestock, and potential wind and water erosion are discussed and various studies are cited to support these claims (page 12 of draft EIS). The commenter is encouraged to view additional information on various grasshoppers at: https://www.sidney.ars.usda.gov/grasshopper/ID_Tools/F_Sheets/index.htm.

APHIS appreciates the commenter's concerns regarding the citation of the Latchininsky et al., 2011 study. APHIS used the study to consider worst-case harm that grasshoppers could cause, but understands the limitations in drawing conclusions from this one study for all outbreaks across the entire country. APHIS wanted to consider potential worst-case scenarios that may occur in treating with chemicals as well as worst-case scenarios if they do not treat with chemicals.

Once APHIS receives a request to chemically treat grasshoppers in an outbreak, APHIS must determine if the grasshopper populations have grown to levels of economic infestation (see footnote 1 on page 6 of the draft EIS) and meet criteria that are defined in the draft EIS. This includes consideration of the pest population, pest life stage, pest and plant species affected, rangeland environmental conditions, cost share with State and private landowners, and the cost benefit of making a treatment (Figure 1-1). If factors indicate low damage or very high treatment costs without much potential for benefits, then treatments would not occur.

While APHIS has not cited data on the length of time that grasshopper damage to *foliage would last, it is conceivable that it would vary depending on numerous factors such as plant type present, the amount of damage and severity of damage, water availability, and temperatures, to name a few. If damage to foliage was not significant, and it was believed that regrowth could happen quickly, it is conceivable that chemical treatment would not be necessary.*

Comment 24

Two commenters indicated that the final EIS must provide better guidance to determine appropriate density to trigger implementation of control measures (i.e., number of crickets/acre for each species) and provide more specific explanation of the level of economic infestation that would trigger insecticide spraying; high grasshopper densities may not cause economic damage. View Laws and Joern, 2012, 2013, and 2017. "The EIS claims that assemblages of grasshoppers at high densities can be equally as damaging as outbreaks of a single pest species (draft EIS pages 9, 70), but no evidence or citations are provided to support this claim."

APHIS agrees with the commenter that high grasshopper densities may not cause economic damage. There is no simple equation for showing when treatments would occur (i.e., number of crickets/acre), as requested by a second commenter. Many factors influence the impact of grasshoppers on rangeland, and therefore, go in to making a decision whether APHIS should chemically treat. Factors include presence of food, grasshopper species, grasshopper density, condition of the habitat (overgrazed, drought, etc.), grasshopper physiology (growth stage and sex), presence of predators and pathogens, and weather (rainfall and temperature) (see page 12 of draft EIS). These factors all serve as the baseline range conditions which APHIS considers prior to making any decision to treat. In addition to the environmental baseline conditions, APHIS also considers other factors such as pest population, pest life stage, pest and plant species affected, cost share with State and private landowners, and the cost benefit of making a treatment (Figure 1-1).

APHIS indicates on page 70 of the draft EIS that, "Although each grasshopper species alone may not cause significant damage, a combination of species in an area may cause extensive damage to rangeland. The economic damage resulting from high grasshopper density and the resulting defoliation may reach an economic threshold". APHIS is not indicating that this situation will occur, but may occur. Again, APHIS will not chemically treat unless a thorough analysis of all factors listed above have been considered. The final EIS was updated to clarify that more than one species of grasshopper may result in damage to rangeland.

A more in-depth description of the "level of economic infestation" was in the document as a footnote. Generally, NEPA documents are supposed to be written in a manner that can be understood by all of the general public. APHIS realizes that certain individuals and groups may need or want more thorough explanations and typically this information is put in footnotes or in appendices.

The footnote on "level of economic infestation", which describes the threshold in greater depth, can be found on page 6 of the draft EIS and states the following:

"The "level of economic infestation" is a measurement of the economic losses caused by a particular population level of grasshoppers to the infested rangeland. This value is determined on a case-by-case basis with knowledge of many factors including, but not limited to, the following: economic use of available forage or crops; grasshopper species, age, and density present; rangeland productivity and composition; accessibility and cost of alternative forage; and weather patterns. In decision-making, the level of economic infestation is balanced against the cost of treating to determine an "economic threshold" below which there would not be an overall economic benefit for the treatment. Short-term economic benefits accrue during the years of treatments, but additional long-term benefit may accrue and be considered in deciding the total value gained by a treatment. Additional losses to rangeland habitat and cultural and personal values (e.g., aesthetics and cultural resources), although they may also be a part of decision-making, are not part of the economic values in determining the necessity for treatment (USDA APHIS, 2002)."

Comment 25

USDA APHIS received comments from the registrants for carbaryl, chlorantraniliprole and malathion. Comments were directed at the human health and ecological risk assessments for each insecticide. Comments ranged from requesting inclusion of additional toxicity and environmental effects data for each product to clarifying information or correcting information presented in the risk assessments.

APHIS appreciates the additional information that was provided by each registrant for each of the three insecticides. The risk assessments were updated to include relevant publicly available information provided by each registrant, where applicable. The risk assessments were also updated to clarify or correct information presented in the draft risk assessments, where appropriate.

Comment 26

One commenter disagrees with chemical control of Mormon crickets in western rangelands and would like data indicating they damage western rangelands since they rarely stay in one place long enough to do damage. Additionally Mormon crickets are incorrectly described in the EIS as herbivores.

APHIS documented that the crickets move in bands, but does not agree with the commenter that they cannot cause significant damage because they are moving so quickly. The potential for the cricket to cause damage is documented in the EIS. Additionally, APHIS did not indicate whether or not the crickets were herbivores, but focused on the fact that Mormon crickets consume a vast range of plant types (page 10 of draft EIS), "They are destructive to range plants because they *consume young plants, the flowering parts and seeds of grasses, and defoliate larger browse plants and shrubs (Wakeland, 1959). Mormon crickets also damage wheat, barley, alfalfa, sweetclover, and commercial and garden vegetables (Pfadt, 1994)" (page 12 of draft EIS). APHIS encourages the commenter to review USDA ARS' website on Mormon crickets, available at: https://www.sidney.ars.usda.gov/grasshopper/ID_Tools/F_Sheets/mormoncr.htm and https://www.sidney.ars.usda.gov/grasshopper/Research/mcricket.htm*

APHIS would only decide to treat chemically for Mormon crickets after surveying the site, reviewing the factors listed in response to comment 24, and determining the crickets were at a level of economic infestation.

Comment 27

A comment was received stating that USDA APHIS estimated acute and chronic risk of carbaryl use to non-target birds and mammals without adequate explanation of the assumptions in estimating those risks The commenter further states that APHIS downplayed the risks and did not consider other factors (ex. species extrapolation, extrapolation of laboratory animal toxicity data to wild species, chemical mixture effects, other stressors) in its estimate of risks to wild mammals and birds in its risk assessment.

APHIS estimated carbaryl risk to mammals and birds using USEPA exposure models and methods for estimating risks from carbaryl liquid and bait applications. The models are part of the process for conducting a screening level ecological risk assessment for pesticide registrations. To estimate acute risk to mammals, APHIS used a no observable effect level (NOEL) effects endpoint compared to the lowest acute LD_{50} which is typically used as the acute effects endpoint in these types of estimates. The NOEL was based on a statistically significant effect at the next highest dose in a study that measured cholinesterase inhibition. The chronic effects mammalian endpoint that was used was based on a two-generation study using the rat. Animals were dosed daily for 10 weeks in the study. A 10 week chronic exposure is not expected to occur in the Program based on the number of applications and environmental fate of carbaryl. APHIS makes one application and after treatment carbaryl would degrade and dissipate reducing exposure. The other estimate of mammalian chronic risk made in the carbaryl risk assessment used the No Observable Effect Concentration (NOEC) from a two-year chronic study using the rat. This estimate showed a slight exceedance of 1.0 suggesting chronic risk to mammals from liquid applications of carbaryl, however the effect endpoint was based on a two year dosing study. These types of exposures would not occur in actual field applications of carbaryl since only one treatment is made per season.

Risk estimates to birds demonstrated some acute risk based on the lowest reported oral LD_{50} value for carbaryl. Risk was greatest for small and medium-sized birds *that use plant material as a food source. Acute risks were below levels of concern when using the lowest available dietary LC_{50} values for birds. Chronic risks to birds was below levels of concern using the most sensitive NOEC and upper bound estimates of exposure to carbaryl-treated food items.*

Estimates of acute risk were higher for carbaryl bait applications compared to liquid applications for mammals and birds. The LD_{50} per square foot method provides a measure of the amount of pesticide in a square foot that can result in mortality to 50% of the animals. The method has limited ecological relevance due to the selection of an arbitrary area for exposure but assumes as the value increases there is an increase in risk. For mammals, APHIS used the acute NOEL measuring cholinesterase inhibition (10 mg/kg) compared to the much higher acute oral LD_{50} value for carbaryl that would result in lower risk quotient values.

The estimates of risk using these methods assumes that the non-target species will feed exclusively on treated bait when other untreated food sources would also be available as a food source. The exposure model estimates for liquid applications used in the carbaryl ecological risk assessment were upper bound estimates. In the case of treated baits the estimate of risk assumes that none of the treated bait will be removed by the target pest species. In actual applications, treated bait would be consumed by the target species reducing bait for consumption by non-target birds and mammals.

APHIS recognizes the uncertainties in conducting ecological risk assessments. These are discussed in the uncertainties section of the carbaryl human health and ecological risk assessment. The selection of conservative effects and environmental fate data in estimating risks and exposure are intended to account for some of the uncertainties and data gaps common to risk assessments. APHIS' intent is not to "downplay" the risks of carbaryl to non-target fish and wildlife in the carbaryl risk assessment. APHIS estimated potential risks using standard screening level methods and discussed the results of those estimates relative to published field collected data and based on those results determined that the risk is low in most cases. The risk assessment was updated to provide further clarification on the assumptions and limitations of the carbaryl risk assessment for birds, mammals and reptiles.

Comment 28

USDA APHIS received a comment that the final EIS must consider risks to imperiled bee and butterfly species.

Potential impacts to Lepidoptera, the largest order in the class Insecta, which includes moths, skippers, and butterflies, are discussed under each potential chemical treatment. A thorough analysis of potential impacts on Lepidoptera from carbaryl are discussed on pages 41 and 45; from diflubenzuron on pages 51, 52, 55, and 56; from malathion on page 63; from chlorantraniliprole on pages 75 and

76 of the draft EIS. Risks to hymenopterans, which refers to a large order of insects that include wasps and bees, are also discussed under each potential chemical treatment. Potential impacts to hymenopterans from carbaryl are on pages 41 and 45; from diflubenzuron on pages 55, 56, and 57; from chlorantraniliprole on page 76 of the draft EIS.

Discussion of potential impacts to bees and butterflies are also found under the sections titled, "Pollinators". Impacts to pollinators (such as bees) from carbaryl, with potential mitigations, are on pages 45 and 46; from diflubenzuron on pages 57 and 58; from malathion on page 65; from chlorantraniliprole on page 76 of the draft EIS. Additional information regarding impacts to pollinators and other terrestrial invertebrates are discussed in the human health and ecological risk assessments that are cited in the draft EIS.

Should the bees or butterfly species be considered threatened or endangered, they would be considered under the Endangered Species Act, as addressed in comments 4 and 5.

Comment 29

APHIS received two comments that the agency should encourage and implement Integrated Pest Management (IPM) activities for managing grasshoppers and Mormon Crickets.

APHIS supports the use of IPM in the management of grasshoppers and Mormon Crickets. APHIS provides technical assistance to Federal, Tribal, State and private land managers including the use of IPM. However, implementation of on-the-ground IPM activities is limited to land management agencies and Tribes, as well as private land owners. In addition, APHIS' authority under the Plant Protection Act is to treat Federal, State and private lands for grasshoppers and Mormon cricket populations. APHIS' technical assistance occurs under each of the three alternatives proposed in this EIS.

In addition to providing technical assistance, APHIS completed the Grasshopper Integrated Pest Management (GIPM) project, which is discussed in more detail on page 21 of this EIS. One of the goals of the GIPM is to develop new methods of suppressing grasshopper and Mormon cricket populations that will reduce non-target effects. RAATs are one of the methods that has been developed to reduce the amount of pesticide used in suppression activities, and is a component of IPM. APHIS continues to evaluate new suppression tools and methods for grasshopper and Mormon cricket populations, including biological control, and as stated in this EIS, will implement those methods once proven effective and approved for use in the United States.

Glossary and Acronyms

A

Acetylcholinesterase (AChE)	An enzyme produced at junctions in the nervous system that inactivates acetylcholine, thereby ending transmission of a nerve impulse once it has passed the junction.
AChE	See Acetylcholinesterase
Active Ingredient (a.i.)	The effective control agent of a pesticide formulation or the actual amount of the technical material present in the formulation.
Acute Toxicity	The potential of a substance to cause injury or illness when given in a single dose or in multiple doses over a period of 24 hours or less; in aquatic studies, exposure to a given concentration would be for 96 hours or less.
a.i.	See Active Ingredient
Amphipod	Any of a large group of small, aquatic crustaceans, commonly called scuds, with laterally compressed bodies.
Animal and Plant Health Inspection Service (APHIS)	An agency of the U.S. Department of Agriculture.
APHIS	See Animal and Plant Health Inspection Service
Arthropod	Members of the phylum Arthropoda include the insects, the crustaceans (crabs, lobsters, and shrimp), the arachnids (spiders, ticks, and scorpions), the millipedes, and centipedes. The arthropod is characterized by a rigid external body covering called a cuticle or exoskeleton, a segmented body, and paired, jointed appendages with at least one pair of functional jaws.

B

BA	See Biological Assessment
Bureau of Indian Affairs (BIA)	An agency of the U.S. Department of the Interior.

Bioaccumulation	The process of a plant or animal selectively taking in or storing a persistent substance over a period; a higher concentration of the substance is found in the organism than in the organism's environment.
Biological Assessment (BA)	The document prepared to assess the potential impacts of a program on endangered and threatened species and their habitats.
BLM	See Bureau of Land Management
Bureau of Land Management (BLM)	An agency of the U.S. Department of the Interior.

C

Carbaryl	A broad-spectrum carbamate insecticide that inhibits acetylcholinesterase.
Carcinogen	Substance that causes cancer.
CEQ	See Council on Environmental Quality
Council on Environmental Quality (CEQ)	The agency that oversees implementation of the National Environmental Policy Act.
CFR	Code of Federal Regulations (U.S.).
Chemical Degradation	The breakdown of a chemical substance into simpler components through chemical reactions.
Chitin	A polysaccharide, hard substance that forms the outer cover of insects, crustaceans, and some other invertebrates.
Chlorantraniliprole	An insecticide of the ryanoid class.
Cholinesterase (ChE)	Any enzyme that catalyzes the hydrolysis of choline esters, for example, acetylcholinesterase catalyzes the breakdown of acetylcholine to acetic acid and choline.
Chronic Toxicity	Harmful effects of a chemical from prolonged exposure or repeated administration.
Cooperator	A landowner, Federal, State, or private individual, agency, or group that is involved in a grasshopper or Mormon cricket control program

as a co-decision-maker or financially through an established cost-sharing formula.

Cropland	Any area planted with the intent to harvest. Crops planted and then grazed because of drought or insufficient growth will be considered cropland. Fallow land also will be considered cropland.
Cumulative Impacts	". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7)

D

DEIS	Draft environmental impact statement. See Environmental Impact Statement.
Diapause	A period of spontaneous dormancy independent of environmental conditions interrupting developmental activity in an embryo, larva, or pupa, or arresting reproductive activity in an adult insect and usually occurring during hibernation or estivation.
Diflubenzuron	An insect growth-regulating insecticide that inhibits the formation of chitin.
Diptera	Flies, mosquitoes, midges, and the like, that constitute a group of insects characterized by having only one pair of functional wings; a second nonfunctional pair is reduced to small knobbed structures called halteres.
Drift	That portion of a sprayed chemical that moves off a target site because of wind.

E

EA	See Environmental Assessment
Economic Infestation	A measurement of the economic losses caused by a particular population level of grasshoppers or Mormon crickets to the designated rangeland.
EIS	See Environmental Impact Statement

Endangered Species	Any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range.
Endangered Species Act (ESA)	A Federal law that regulates the conservation of endangered and threatened species and their habitats.
Environmental Assessment (EA)	An environmental document, prepared to comply with the National Environmental Policy Act of 1969, wherein the environmental impacts of a planned action (in this case grasshopper control programs) are objectively reviewed.
Environmental Impact Statement (EIS)	A document prepared by a Federal agency in which anticipated environmental effects of alternative planned courses of action are evaluated; a detailed written statement as required by section 102(2)(C) of the National Environmental Policy Act (NEPA).
E.O.	See Executive Order
Executive Order (E.O.)	A form of executive lawmaking implemented by the President.
Exoskeleton	The hard outer casing of an insect that is made of chitin.
Exposure Analysis	The estimation of the amount of chemicals that organisms receive during application of pesticides.

F

Family	A group of related plants or animals forming a category ranking above a genus and below an order, usually comprising several to many genera, but sometimes including a single genus of notably distinctive characters.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	A Federal law that provides the overall framework for the Federal pesticide program.
FIFRA	See Federal Insecticide, Fungicide, and Rodenticide Act
Fish and Wildlife Service (USFWS)	An agency of the U.S. Department of the Interior.
Forage	All browse and nonwoody plants available to livestock or wildlife for grazing or harvesting for feed.

Forage Production The weight of forage that is produced within a designated period on a given area. The weight may be expressed as either green, air-dry, or oven-dry. The term may also be modified as to time of production such as annual, current year, or seasonal forage production.

Forb An herbaceous plant other than a grass, especially one growing in a field or meadow.

Forest Service (FS) An agency of the U.S. Department of Agriculture.

***Federal Register* (FR)** The official daily publication for Rules, Proposed Rules, and Notices of Federal agencies and organizations, as well as Executive Orders and other Presidential documents.

Formulation The form in which a pesticide is packaged or prepared for use. A chemical mixture that includes a certain percentage of active ingredient (technical chemical) with an inert carrier.

G

Genus A taxonomic category ranking below a family and above a species; used in taxonomic nomenclature, either alone or followed by a Latin adjective or epithet, to form the scientific name of a species.

GHIPM The Grasshopper Integrated Pest Management Program.

Granivorous Feeding on grains and seeds.

H

Half-life The time required for a substance (such as an insecticide) in or introduced into a living or nonliving system to be reduced to half of its original amount whether by excretion, metabolic decomposition, or other natural process.

Hazard Analysis The determination of whether a particular chemical is or is not causally linked to particular harmful effects.

HHERA Human Health and Ecological Risk Assessment

Herbivore An animal that feeds exclusively on plants.

Hydrolysis Decomposition or alteration of a chemical substance by water.

Hymenoptera — A large order of insects comprised of the ants, bees, sawflies, and wasps. The typical adult has four membranous wings and chewing-type mouthparts.

I

Integrated Pest Management (IPM) — The selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences; the process of integrating and applying practical methods of prevention and control to keep pest situations from reaching damaging levels while minimizing potentially harmful effects of pest control measures on humans, non-target species, and the environment.

Insectivorous — Insect-eating; in common usage, includes animals that eat insects and sometimes other selected invertebrates.

Instar — The term for an insect before each of the molts (shedding of its skin) it must go through in order to increase in size. Upon hatching from its egg, the insect is in instar I and is so called until it molts, when it begins instar II, and so forth.

Invertebrate Drift — Movement of aquatic insects and crustaceans downstream with the current in flowing water that results from exposure to substances that elicit repellant or toxic responses.

L

Leach — Usually refers to the movement of chemicals through soil by water; may also refer to the movement of herbicides out of leaves, stems, or roots into the air or soil.

Lepidoptera — A large order of insects, including the butterflies and moths, characterized by four scale-covered wings and coiled, sucking mouthparts.

M

Malathion — A broad-spectrum organophosphate insecticide that inhibits acetylcholinesterase.

Metabolite — A product of the chemical changes in living cells that provides energy and assimilates new material.

Methemoglobin — The compound in blood responsible for transport of oxygen.

Methemoglobinemia	The condition where the heme iron in blood is oxidized chemically and lacks the ability to properly transport oxygen.
Microbial Degradation	The breakdown of a chemical substance into simpler components by bacteria.
Microgram	One-millionth of a gram; abbreviated as µg.
Molt	To shed or cast off hair, feathers, shell, horns, or an outer layer of skin in a process of growth or periodic renewal with the cast-off parts being replaced by new growth.
Moribund	At or near the point of death.

N

National Environmental Policy Act of 1969 (NEPA)	The act whereby Federal agencies evaluate the potential effects of a proposed action and its alternatives on the human environment.
National Marine Fisheries Service (NMFS)	An agency of the U.S. Department of Commerce.
NEPA	See National Environmental Policy Act
Non-target Organisms	Those organisms (species) that are not the focus of insecticide treatments.
Nymph	Any insect larva that differs chiefly in size and degree of differentiation from the adult.

O

Omnivorous	Eating both animal and plant substances.
Oncogenic	Capable of producing or inducing tumors, either benign (noncancerous) or malignant (cancerous), in animals.
Order	A category of taxonomic classification ranking above family and below class and often being made up of several families.
Orthoptera	An order of Insecta comprising insects with mouthparts fitted for chewing, two pairs of wings or none, and an incomplete metamorphosis.

Outbreak	An explosive increase in the abundance of a particular species that occurs over a relatively short period.

P

Pesticide	Any substance or mixture of substances used in controlling insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests.
Phytotoxic	Poisonous or harmful to plants.
Plecoptera	An order of Insecta, stoneflies, characterized by aquatic nymphs that are mostly phytophagous.
Plant Protection Act (PPA)	The Plant Protection Act.
Plant Protection and Quarantine (PPQ)	A program within the Animal and Plant Health Inspection Service, U.S. Department of Agriculture.
PPA	See Plant Protection Act
PPQ	See Plant Protection and Quarantine

R

Reduced Agent Area Treatments (RAATs)	A grasshopper suppression method in which the rate of insecticide is reduced from conventional levels, and treated swaths are alternated with swaths that are not directly treated.
Rangeland	An area on which the vegetation consists of native or introduced grasses, legumes, grasslike plants, forbs, or shrubs, and that is developed for range (grazing) use. Also counted as rangeland is native pastures or meadows that are occasionally cut or mechanically harvested and are grazed by livestock.
Riparian Area	Land areas that are influenced directly by water. They usually have visible vegetative or physical characteristics reflecting this water influence. Streamsides, lake borders, or marshes are typical riparian areas.
Riparian Habitat	Those terrestrial areas where the vegetation complex and microclimatic conditions are products of the combined presence and influence of perennial or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. Includes

riparian zones plus one-half the transition zone (or ecotone) between riparian zones and upland habitat.

Runoff That part of precipitation, as well as any other flow contributions, that appear in surface streams, either perennially or intermittently.

S

Species A fundamental taxonomic classification category, ranking after a genus and consisting of class or group with distinguishing characteristics and often designated by a common name.

T

Threatened Species Any species of animal or plant that is likely to become an endangered species throughout all or a significant portion of its range within the foreseeable future.

Toxicity A characteristic of a substance that makes it poisonous.

Translocation The transfer of substances from one location to another in the plant body.

T&E Species Threatened and endangered species; Endangered Species Act

U

Ultra-Low-Volume (ULV) Sprays that are applied at 0.5 gallons or less per acre or sprays applied as the undiluted formulation.

U.S.C. United States Code.

U.S. Department of Agriculture (USDA) The department in which the Animal and Plant Health Inspection Service and the Forest Service are located.

U.S. Department of the Interior (DOI) The department in which the Bureau of Indian Affairs, the Bureau of Land Management, and the Fish and Wildlife Service are located.

U.S. Department of Commerce (DOC) The department in which the National Marine Fisheries Service is located.

U.S. Environmental Protection Agency (USEPA) The Federal agency that creates and enforces environmental regulations such as FIFRA.

USEPA	See U.S. Environmental Protection Agency
USFWS	See Fish and Wildlife Service

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