

# Draft Environmental Assessment Rangeland Grasshopper and Mormon Cricket Suppression Program

## Moffat, Rio Blanco and Routt Counties, Colorado

PPQ and CEQ Identification Number: CO-25-01-EAXX-005-32-24P-1741344432

### **Prepared by:**

United States Department of Agriculture (USDA)  
Animal and Plant Health Inspection Service (APHIS)  
Plant Protection and Quarantine (PPQ)  
3950 N Lewiston Street, Suite 104  
Aurora, CO 80011

Available at Above Address or:

[www.aphis.usda.gov/plant-health/grasshopper](http://www.aphis.usda.gov/plant-health/grasshopper)

December 2025

## Non-Discrimination Policy

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

### To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (PDF) within 45 days of the date of the alleged discriminatory act, event, or in the case of a personnel action. Additional information can be found online at [http://www.ascr.usda.gov/complaint\\_filing\\_file.html](http://www.ascr.usda.gov/complaint_filing_file.html).

### To File a Program Complaint

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: [program.intake@usda.gov](mailto:program.intake@usda.gov).

USDA is an equal opportunity provider, employer, and lender.

### Persons With Disabilities

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

Mention of companies or commercial products in this report does not imply recommendation or endorsement by USDA over others not mentioned. USDA neither guarantees nor warrants the standard of any product mentioned. Product names are mentioned to report factually on available data and to provide specific information.

This publication reports research involving pesticides. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

**CAUTION:** Pesticides can be injurious to humans, domestic animals, desirable plants, and fish and other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended label practices for the use and disposal of pesticides and pesticide containers.

## Table of Contents

### Contents

I.	Need for Proposed Action.....	1
A.	Purpose and Need Statement .....	1
B.	Background Discussion .....	3
1.	Grasshopper Ecology .....	3
2.	Grasshopper Population Control.....	5
3.	APHIS Environmental Compliance and Cooperators.....	7
C.	About This Process .....	8
II.	Alternatives .....	10
A.	Alternatives Considered for Comparative Analysis .....	11
1.	No Suppression Program Alternative .....	11
2.	Insecticide Applications at Conventional Rates or Reduced Agent Area Treatments with Adaptive Management Strategy (Preferred Alternative) .....	11
B.	Protective Measures Including Policies and Consultation Measures to Avoid or Reduce Adverse Impacts.....	14
III.	Environmental Consequences .....	16
A.	Description of Affected Environment.....	16
B.	Special Management Areas.....	18
C.	Effects Evaluated .....	19
D.	Site Specific Considerations and Environmental Issues .....	21
1.	Human Health .....	21
2.	Nontarget Species .....	22
3.	Physical Environment Components.....	30
4.	Socioeconomic Issues .....	31
5.	Cultural Resources and Events .....	31
6.	Special Considerations for Certain Populations .....	32
E.	Environmental Consequences of the Alternatives .....	32
1.	Alternative 1 - No Suppression Program Alternative .....	33
2.	Alternative 2 -Insecticide Applications at Conventional Rates or Reduced Agent Area Treatments with Adaptive Management Strategy.....	36
IV.	Conclusion .....	52
V.	Literature Cited .....	53
VI.	Listing of Agencies and Persons Consulted.....	64
	Appendix A.....	65
	APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program.....	65
	Appendix B: Map of the Affected Environment.....	69
	Appendix C: Summary of Protection Measures (treatment buffers) for Listed Species .....	71

## Acronyms and Abbreviations

ac	acre
a.i.	active ingredient
AChE	acetylcholinesterase
APHIS	Animal and Plant Health Inspection Service
BLM	Bureau of Land Management
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
EA	environmental assessment
e.g.	example given (Latin, <i>exempli gratia</i> , “for the sake of example”)
EIS	environmental impact statement
E.O.	Executive Order
FONSI	finding of no significant impact
EIL	economic injury level
g	gram
ha	hectare
HHERA	human health and ecological risk assessments
i.e.	in explanation (Latin, <i>id est</i> “in other words.”)
IPM	integrated pest management
lb	pound
MBTA	Migratory Bird Treaty Act
MOU	memorandum of understanding
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NIH	National Institute of Health
ppm	parts per million
PPE	personal protective equipment
PPQ	Plant Protection and Quarantine
RAATs	reduced agent area treatments
ULV	ultra-low volume
U.S.C.	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Services

## **Draft Site-Specific Environmental Assessment**

### **Rangeland Grasshopper and Mormon Cricket Suppression Program Moffat, Rio Blanco and Routt Counties, Colorado**

## **I. Need for Proposed Action**

### ***A. Purpose and Need Statement***

An infestation of grasshoppers or Mormon crickets may occur in Moffat, Rio Blanco and Routt counties, Colorado. The Animal and Plant Health Inspection Service (APHIS) based on location of infestation may, upon request by land managers or State departments of agriculture, conduct treatments to suppress grasshopper infestations as part of the Rangeland Grasshopper and Mormon Cricket Suppression Program (program). The term “grasshopper” used in this environmental assessment (EA) refers to both grasshoppers and Mormon crickets, unless differentiation is necessary.

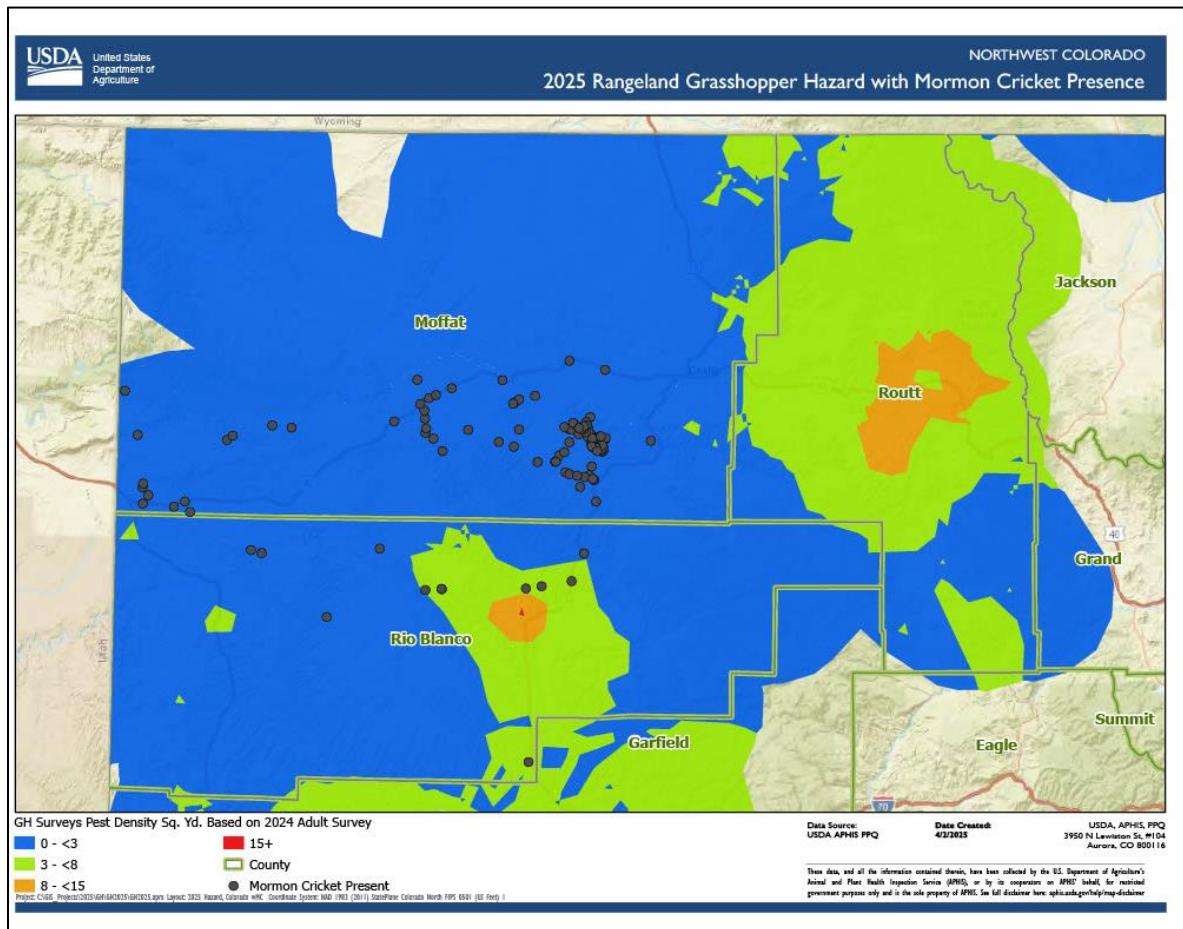
Under the guidance of Section 417 of the Plant Protection Act of 2000, USDA plays a coordinating role between Federal agencies, State agricultural departments, and private ranchers to control both grasshoppers and Mormon crickets. Section 417(a) of the Plant Protection Act of 2000, as amended (7 U.S.C. 7701(a)), states that APHIS “shall carry out a program to control grasshoppers and Mormon crickets on all Federal lands to protect rangeland.” Upon request from the land manager, APHIS “shall immediately treat Federal, State, or private lands that are infested with grasshoppers or Mormon crickets at levels of economic infestation, unless the Secretary determines that delaying treatment will not cause greater economic damage to adjacent owners of rangeland” (7 U.S.C. 7717(c)(1)). The Act further specifies that APHIS “shall work in conjunction with other Federal, State, and private prevention, control, or suppression efforts to protect rangeland” (7 U.S.C. 7717(c)(2)). APHIS does not engage in grasshopper suppression efforts unless assistance is specifically requested by an affected landowner or land manager.

Populations of grasshoppers that trigger the need for APHIS suppression program are normally considered on a case-by-case basis and are difficult to predict. Through late summer and autumn adult grasshopper surveys, APHIS can sometimes forecast areas where damaging grasshopper populations may occur during the following year (the next summer). Land managers and property owners request APHIS assistance to control grasshopper outbreaks because of a history of damage, the potential damage to rangeland resources forecast in the current year, and as determined by spring nymphal assessment and delimitation surveys conducted prior to the summer treatment season. Some benefits of preventing high populations of grasshoppers include saving forage for wildlife and livestock, along with preventing the loss of sensitive plant species from grasshopper feeding.

Rural economies depend on rangelands that managed for productive forage to provide for livestock grazing. A reduction in forage has a significant impact on cattle health and gain which adversely impacts producers and their livelihoods. Economic values of rangelands also include energy production sites, both fossil and renewable, and recreation sites. In

addition to these direct market values, rangelands also provide important ecosystem services, such as purification of air and water, water conservation, generation and preservation of soils and renewal of their fertility, detoxification and decomposition of wastes and pollutants, pollination of crops and natural vegetation, dispersal of seeds, cycling and movement of nutrients, control of potential agricultural pests, maintenance of biodiversity, and aesthetic beauty. Rangeland treatments can also prevent grasshoppers and Mormon crickets from moving into adjacent cropland and causing damage to high value crops. Mormon crickets also pose a safety issue which can be reduced by treating rangeland. Mormon cricket bands can create dangerous driving conditions that when they move off of rangeland onto roads, are crushed by vehicles and can make roads slick and unsafe.

The goal of the proposed suppression program analyzed in this Environmental Assessment (EA) is to reduce grasshopper populations below economic injury levels in order to protect the natural resources of rangeland ecosystems, the value of livestock and wildlife forage, and cropland adjacent to rangeland.



*Figure 1. 2025 Rangeland Grasshopper Hazard with Mormon Cricket Presence Map*

This EA is prepared in accordance with the requirements under the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq.*); Council on Environmental Quality's (CEQ)

regulations implementing NEPA (40 CFR 1500 *et seq.*); USDA (7 CFR Part 1b) and APHIS NEPA Implementing Procedures (7 CFR Part 372). APHIS will make and issue a decision based on the analysis presented in this EA, the results of public involvement, and consultation with other agencies and individuals. A selection of one of the program alternatives will be made by APHIS in 2025 and for subsequent years until and unless an updated EA is prepared, for rangeland in Moffat, Rio Blanco and Routt counties, Colorado.

APHIS is aware of the November 12, 2024 decision in Marin Audubon Society v. Federal Aviation Administration, No. 23-1067 (D.C. Cir. Nov. 12, 2024). To the extent that a court may conclude that the CEQ regulations implementing NEPA are not judicially enforceable or binding on this agency action, APHIS has nonetheless elected to follow those regulations at 40 C.F.R. Parts 1500– 1508, in addition to the APHIS’s procedures and regulations implementing NEPA at 7 CFR Part 372, to meet the agency’s obligations under NEPA, 42 U.S.C. §§ 4321 *et seq.*

## ***B. Background Discussion***

### **1. Grasshopper Ecology**

Rangelands provide many goods and services, including food, fiber, recreational opportunities, and grazing land for cattle (Havstad et al., 2007; Follett and Reed, 2010). Grasshoppers and Mormon crickets are part of rangeland ecosystems, serving as food for wildlife and playing an important role in nutrient cycling. However, grasshoppers and Mormon crickets have the potential to occur at high population 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). Out of approximately 650 western grasshopper species, only 10 to 15 are recurrent economic pests. However, even during “normal” population years, they remove over 20% of above-ground rangeland forage annually at an estimated cost of \$1.2 billion per year (Hewitt & Onsager, 1983; dollar amount adjusted). During severe outbreaks, grasshoppers consume substantial forage, which may disrupt the ecological functioning of rangelands (Rashford et al., 2012).

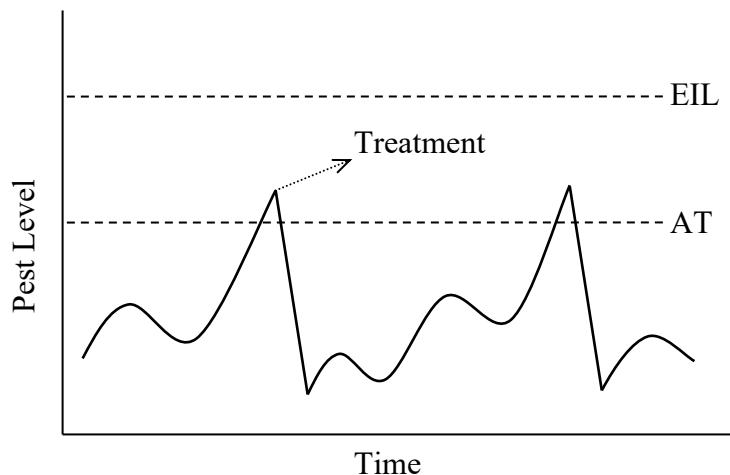
APHIS supports the use of Integrated Pest Management (IPM) principles in the management of grasshoppers and Mormon Crickets. Integrated pest management is the selection, integration, and implementation of pest control tactics in a systems approach on the basis of anticipated economic, environmental, and sociological consequences. The economic injury level (EIL) concept is the most widely accepted decision-making framework for pest management (Pedigo et al. 1986). The basic principle is to determine the pest level (e.g., population per unit area) that results in monetary damages greater than the cost of treatment – benefit cost ratio greater than one in standard economic terminology. The mathematical formulations can vary depending on the application and data available, but the basic formulation for EIL is given by (see Higley and Pedigo 1996):

$$EIL = \frac{C}{VDK},$$

where,  $C$  is treatment cost (e.g., \$/acre),  $V$  is market value per unit of production (e.g., \$/lb),  $D$  is production loss per pest (e.g., lb/pest) and  $K$  is the proportional reduction in loss from

applying control. The EIL identifies the pest population (e.g., pest/acre) that justifies spending  $C$  dollars on control.

The EIL can be used as an actionable criterion; however, given pest population dynamics and delays in treatment effect, applying treatment once EIL pest levels are observed may result in substantial economic losses. APHIS and our cooperators assess whether grasshopper populations are exceeding an action threshold (historically termed the “economic infestation level”), which identifies the pest level when treatment should be initiated to avoid an increasing pest population from reaching the EIL. The action threshold therefore identifies a temporal criterion to initiate management given observations of pest levels (Figure 1). Action thresholds can be developed in a variety of ways including subjective determinations based on local experience, to objective functions of the EIL.



*Figure 2. Diagram of the typical relationship between the economic injury level (EIL) and action threshold (AT) for applying pest treatments (Rashford et al., 2012).*

The “economic injury level” 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 injury is balanced against the cost of treating to determine an “economic threshold” below which there would not be an overall 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 treatment. Grasshopper caused losses to rangeland habitat and cultural and personal values (e.g., aesthetics and cultural resources), although a part of decision making, are not part of the economic values in determining the necessity of treatment.

While market prices are good proxies for the direct market value of commodities damaged by pests (e.g., crops or forage), market prices do not capture all of the potential economic values affected by pests. Market prices, for example, can be highly variable over time and space, depending on local supply and demand conditions (Rashford et al., 2012).

## 2. Grasshopper Population Control

Grasshopper populations sometimes build to economic injury levels despite even the best land management and other efforts to prevent outbreaks. Land managers traditionally use tools including integrated pest management practices to maximize the production of healthy vegetation. While APHIS provides technical assistance, it is up to the land manager to manage their land for high productivity and healthy range ecosystems. When forage and land management have failed to prevent grasshopper outbreaks insecticides may be needed to reduce the destruction of rangeland vegetation. APHIS' enabling legislation provides, in relevant part, that 'on request of the administering agency or the agriculture department of an affected State, the Secretary, to protect rangeland, shall immediately treat Federal, State, or private lands that are infested with grasshoppers or Mormon crickets' ... (7 U.S.C. § 7717(c)(1)).

Under the guidance of Section 417 of the Plant Protection Act of 2000, USDA plays a coordinating role between federal agencies, state agricultural departments, and private ranchers to control both grasshoppers and Mormon crickets. APHIS accomplishes this by conducting cooperative surveys during the early spring and late summer to measure both nymphal and adult populations of grasshoppers, respectively. The annual adult surveys can be used to forecast grasshopper population levels in the following year. Where outbreaks are common, the program selectively employs nymphal surveys to delimit potential treatment boundaries.

IPM procedures are thoroughly incorporated into the management of grasshoppers by APHIS. IPM strategies consider economic, environmental, and pesticide resistance consequences of pest control tactics. The primary objective of IPM is to control agricultural pest populations below the economic injury level. APHIS published a programmatic EIS in 1987 for rangeland grasshopper control that included IPM methods as the preferred alternative. At that time APHIS expected the IPM alternative would primarily include biological or chemical methods for grasshopper control. APHIS would continue to participate in research and testing to identify other feasible cultural and mechanical control methods. The current program uses IPM principles by selecting a particular control method on an individual site after taking into consideration of economic (the cost and the cost-effectiveness of various methods in both the short and long term), ecological (the impact on nontarget organisms and the environment), and sociological (the acceptability of various IPM methods to cooperators, or the potential effects on land use) factors.

APHIS uses survey data to inform stakeholders of the potential for economic damage associated with grasshoppers. The program also provides technical assistance on insecticides, application methodology and cost benefit analysis to equip land managers with information needed to make economically and environmentally sound grasshopper treatment decisions.

APHIS responds to solicitations from land managers to assess, and if necessary, suppresses grasshopper infestations. While many stakeholders interact with the program, Federal Land Managers represent about 75% of suppression requests. Engaging in grasshopper suppression is complicated, and funding, rangeland conditions, environmental regulations, politics and public sentiment all impact the process. The need for rapid and effective response when an outbreak occurs limits the options available to APHIS. The application of

an insecticide within all or part of the outbreak area is often the only response available to APHIS to rapidly suppress or reduce grasshopper populations and effectively protect rangeland (USDA APHIS, 2011). 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, costs and benefits of conducting the action, and ecological considerations (USDA APHIS, 2008).

The site-specific data used to make treatment decisions in real time is gathered during spring nymph surveys. Surveys help to determine general areas, among the millions of acres where harmful grasshopper infestations may occur in the spring of the following year. Survey data provides the best estimate of future grasshopper populations, while short-term climate or environmental factors change where the outbreak populations occur. The general site-specific data include: grasshopper densities, species complex, dominant species, dominant life stage, grazing allotment terrain, soil types, range conditions, local weather patterns (wind, temp., precipitation), slope and aspect for hatching beds, animal unit months (AUM's) present in grazing allotment, forage damage estimates, number of potential AUM's consumed by grasshopper population, potential AUM's managed for allotment and value of the AUM, estimated cost of replacement feed for livestock, rotational time frame for grazing allotments, number of livestock in grazing allotment. These are all factors that are considered when determining the economic injury level. Decades of survey data have been collected by APHIS in Colorado. Recent years data has identified both grasshopper and Mormon cricket issues in northwest Colorado. High populations of grasshoppers have been observed in areas of Routt County since 2019. For Mormon crickets in Moffat and Rio Blanco counties, populations have increased significantly over the past six years. Prior to 2020, there were no reported or observed Mormon cricket issues for over 15 years. In 2020, banding populations of Mormon crickets were found, and over subsequent years, the populations have increased and have become more widespread and problematic.

Although APHIS does surveys and considers the factors described above to determine whether treatment is warranted, many grasshopper and Mormon cricket species can be found statewide within suitable habitat meaning that damage or threats of damage to rangelands can occur wherever those species occur. Program activities fall within the category of actions in which the exact location of individual requests for treatments can be difficult to predict with sufficient notice to accurately describe the locations within which APHIS can reasonably expect to be acting. Depending on weather patterns and when hatch occurs, treatments are expected to occur generally from early spring into summer. Mormon cricket treatments will potentially occur from late April into June, and grasshopper treatments are will potentially occur late May until July. But treatments could be outside of these timeframes depending on factors including weather patterns, hatch timing and nymphal development speed. Treatments should occur during the earlier nymphal development stages when nymphal stages are less mobile and treatments using our preferred insecticide diflubenzuron are effective. APHIS needs to respond quickly when a determination is made that treatment is warranted. In the Description of the Affected Environment Section below, APHIS does its utmost to predict locations where treatments may occur based on survey data, past and present requests for treatments, and historical data and trends. However, APHIS cannot predict all the specific locations at which affected resource owners would determine that a rangeland damage problem has become intolerable

to the point that they request treatment, because these locations change from year to year. Therefore, APHIS must be ready for treatment requests on short notice anywhere in Moffat, Rio Blanco and Routt counties, Colorado to protect rangeland where consistent with applicable federal and state laws, land management agency policies, and where funding and resources to conduct treatments are available.

### **3. APHIS Environmental Compliance and Cooperators**

In June 2002, APHIS completed an EIS describing the agency's most effective methods of reducing the damage caused by grasshopper populations in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. During November 2019, APHIS published human health and ecological risk assessments (HHERA) for the use of carbaryl, chlorantraniliprole, diflubenzuron and malathion by the program. APHIS also published an updated EIS to consolidate and incorporate the available data and analyze the environmental risk of new program tools. The risk analysis in the 2019 EIS is incorporated by reference (USDA APHIS, 2019).

On May 31, 2022, Advocates for the West, on behalf of Xerces Society for Invertebrate Conservation (Xerces) and the Center for Biological Diversity, filed a complaint against APHIS, at the United States District Court House in Portland, Oregon. On August 1, 2024, the Court ruled in favor of the plaintiff, finding that USDA violated NEPA. The court found that the 2019 EIS was unreasonably focused on the use of pesticides and did not consider IPM techniques to address outbreaks of grasshoppers. Specifically, the Court described the primary deficiencies of the program's NEPA documents were a failure to consider IPM techniques; a lack of baseline information regarding sensitive species and past pesticide use; a failure to use past data to anticipate future pesticide use; a failure to consider the effects of the program on unique geographic or environmental areas; and a failure to consider the cumulative effects of past and present use of pesticides on the environment when used in geographic or temporal proximity. However, the court stated the 2019 EIS can be relied on for site-specific environmental assessments (EAs) until APHIS corrects the deficiencies in a new EIS. While the in-depth analysis of insecticide based IPM alternatives available to APHIS and nonchemical options for suppressing grasshopper populations available to Federal land management agencies will be included in the new EIS, the other deficiencies described by the Court will be corrected in the site specific EAs.

In August 2024, APHIS and the United States Department of Agriculture Forest Service (FS) signed a Memorandum of Understanding (MOU) detailing cooperative efforts between the two groups on the suppression of grasshoppers on FS system lands (Document # 24-8100-0573-MU, August 16, 2024). This MOU clarifies that APHIS would prepare and issue to the public site-specific environmental documentations that evaluate potential impacts associated with the proposed measures to suppress economically damaging grasshopper populations. The MOU also states that these documents would be prepared under the APHIS NEPA implementation procedures with cooperation and input from the FS.

The MOU further states that the responsible FS official would request in writing the inclusion of appropriate lands in the APHIS suppression project when treatment on FS land is necessary. The FS must also prepare a Pesticide Use Proposal (Form: FS-2100-2) for APHIS to treat infestations. According to the provisions of the MOU, APHIS can begin

treatments after APHIS issues an appropriate decision document and FS prepares and approves the Pesticide Use Proposal.

In January 2022, APHIS and the Bureau of Land management (BLM) signed a Memorandum of Understanding (MOU) detailing cooperative efforts between the two groups on the suppression of grasshoppers on BLM system lands (Document # 22-8100-0870-MU, January 11, 2022). This MOU clarifies that APHIS would prepare and issue to the public site-specific environmental documents that evaluate potential impacts associated with proposed measures to suppress economically damaging grasshopper populations. The MOU also states that these documents would be prepared under the APHIS NEPA implementing procedures with cooperation and input from BLM.

The MOU further states that the responsible BLM official would request in writing the inclusion of appropriate lands in the APHIS suppression project when treatment on BLM land is necessary. The BLM must also prepare a Pesticide Use Proposal for APHIS to treat infestations. According to the provisions of the MOU, APHIS can begin treatments after APHIS issues an appropriate decision document and BLM prepares and approves the Pesticide Use Proposal.

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 landowners. APHIS completed the Grasshopper Integrated Pest Management (GIPM) project. 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. Reduced agent area treatments (RAATs) is one of the methods that has been developed to reduce the amount of pesticide used in suppression activities and is a component of IPM because grasshopper populations are reduced below the level causing economic harm. APHIS typically employs the RAATs method in which the application rate of insecticide is reduced from conventional levels, and treated swaths are alternated with swaths that are not directly treated. The RAATs strategy relies on the effects of an insecticide to suppress grasshoppers within treated swaths while conserving grasshopper predators and parasites in swaths not directly treated (USDA APHIS, 2002). APHIS continues to evaluate new suppression tools and methods for grasshopper and Mormon cricket populations, including biological control.

## ***C. About This Process***

Activities under the Program are subject to the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq.*). APHIS follows the Council on Environmental Quality's (CEQ) guidance implementing NEPA (40 CFR 1500 *et seq.*) along with USDA (7 CFR Part 1b) and APHIS NEPA Implementing Procedures (7 CFR Part 372) as part of the decision-making process. NEPA sets forth the requirement that all federal actions be evaluated in terms of the following:

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

As previously discussed in the Background Discussion section above, the NEPA process for grasshopper management is complicated by the fact that there is a limited window of time when treatments are most effective, and it is difficult to forecast which specific sites within the area covered by this EA will both have requests for treatment and be warranted for treatment to suppress grasshopper outbreaks. As such, the geographic scope of the actions and analyses in this EA is Moffat, Rio Blanco and Routt counties, Colorado to account for the wide geographic areas in which grasshoppers and Mormon crickets occur on rangelands. Then, when grasshopper populations grow to nuisance levels, program managers examine the proposed treatment area to ensure that this EA applies to the specific areas where control activities will be conducted and can act quickly. At the same time, the Program strives to alert the public in a timely manner to its more concrete treatment plans and avoid or minimize harm to the environment in implementing those plans.

Section 1619 of the Farm Bill (7 USC 8791) also prohibits disclosure of certain information from agricultural producers who provide information to participate in programs of the department. Intergovernmental agreements between APHIS and cooperators with Tribal Nations may preclude disclosure of Tribal information to the public without the consent of the Tribal Administrator. Individuals may request information on the specific treatment areas on Tribal Lands from the individual Tribal Nations.

Public involvement under the CEQ Regulations for Implementing the Procedural Provisions of NEPA distinguishes Federal actions with effects of national concern from those with effects primarily of local concern (40 CFR 1501.9). The 2019 EIS is a programmatic analysis of the environmental impacts of the Program across 17 Western States, including Colorado.

To assist with understanding applicable issues and reasonable alternatives to manage grasshopper outbreaks in rangelands and to ensure that the analysis is complete for informed decision making, APHIS has made this Draft EA available for a 30-day public review and comment period. Public outreach notification methods for this EA include publishing in local newspapers; Regulations.gov; Stakeholder Registry Notice and by direct email notifications to stakeholders that have requested notification. After reviewing and considering all timely received comments, APHIS will issue a decision and will notify the public of the decision using the same methods as for the advertising the availability of the Draft EA.

Scoping as defined by NEPA is an early and open process for determining the scope of issues to be addressed by the environmental risk analysis and for identifying the significant issues related to a proposed action (40 CFR 1501.7). APHIS uses the scoping process to enlist land managers and the public to identify alternatives and issues to be considered during the development of a grasshopper suppression program. Scoping was helpful in the preparation of this EA.

In December 2024, APHIS notified the BLM in Colorado that the multiyear EA finalized by APHIS in January 2024 and subsequently adopted by BLM, could no longer be used due the court ruling summarized in the APHIS Environmental Compliance and Cooperators Section in this EA. APHIS and BLM held discussions regarding environmental considerations including insecticide options for this EA. These discussions were also held

with the Colorado Department of Agriculture and county weed and pest staff. APHIS reviewed and considered all comments in preparing the draft EA. Based upon discussions with APHIS leadership and cooperators, we have removed malathion and chlorantraniliprole from this EA, which were included in previous published EA versions for this area.

## II. Alternatives

To engage in comprehensive NEPA risk analysis APHIS must frame potential agency decisions into distinct action alternatives. These program alternatives are then evaluated to determine the significance of environmental effects. The 2019 programmatic EIS looked at the environmental impacts of three different alternatives:

1. Alternative 1: No action alternative, which would maintain the status quo of allowing applications of three pesticides (carbaryl, diflubenzuron, and malathion). Pesticides may be applied as a spray or bait using ground or aerial equipment at full coverage rates or, more typically, by using RAATs.
2. Alternative 2: No suppression alternative where APHIS would not fund or participate in any program to suppress grasshopper infestations. Any suppression program would be implemented by another entity; and
3. Alternative 3: Preferred alternative updates the information allows use of four pesticides (carbaryl, diflubenzuron; malathion; and chlorantraniliprole). Upon request, APHIS would make a single application per year to a treatment area, and would apply it at conventional or, more likely, RAAT rates. The approach to use either conventional treatment or RAATs is an adaptive management feature that allows the Program to make site-specific applications with a range of rates to ensure adequate suppression. The preferred alternative further incorporates adaptive management by allowing treatments that may be approved in the future, and by including protocols for assessing the safety and efficacy of any future treatment when compared to currently approved treatments.

APHIS selected Alternative 3 in the Record of Decision (ROD). However, under each alternative APHIS would conduct survey activities, provide technical assistance, and may make insecticide treatments according to the agency's authority under the Plant Protection Act. 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. Under all the alternatives considered in the EIS APHIS would continue to conduct grasshopper surveys and provide information on ways to manage grasshopper populations in the long-term, such as livestock grazing methods and cultural control by farmers.

APHIS has funded the investigation of various 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 ([www.sidney.ars.usda.gov/grasshopper/index.htm](http://www.sidney.ars.usda.gov/grasshopper/index.htm)).

The 2019 programmatic EIS provides a solid analytical foundation, but no site-specific suppression pesticide treatments are implemented relying entirely on the risk analysis of the EIS and ROD. The EIS provides the basic background information needed for the "tiering" of future project-specific analyses on rangelands in accordance with the CEQ regulations for implementing NEPA. APHIS instead prepares state-or site-specific EAs to address local issues before implementing suppression pesticide treatments. Therefore, APHIS decided to prepare an EA for Moffat, Rio Blanco and Routt counties, Colorado to analyze more site-specific impacts. The EA tiers to the 2019 programmatic EIS and incorporates by reference the carbaryl and diflubenzuron HHERAs also published in 2019. Copies of the 2019 programmatic EIS and ROD are available for review at 3950 North Lewiston Street, Suite 104, Aurora, CO 80011. These documents are also available at the Rangeland Grasshopper and Mormon Cricket Program web site, <http://www.aphis.usda.gov/plant-health/grasshopper>.

## ***A. Alternatives Considered for Comparative Analysis***

### **1. No Suppression Program Alternative**

Under Alternative A, the No Action alternative, APHIS would not conduct a program to suppress grasshopper infestations within Moffat, Rio Blanco and Routt counties, Colorado. Under this alternative, APHIS would continue to conduct grasshopper surveys and provide information on ways to manage grasshopper populations in the long-term, such as different livestock grazing methods and cultural control by farmers. 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.

### **2. Insecticide Applications at Conventional Rates or Reduced Agent Area Treatments with Adaptive Management Strategy (Preferred Alternative)**

Under Alternative B, the Preferred Alternative, APHIS would manage a grasshopper treatment program using techniques and tools discussed hereafter to suppress outbreaks. The insecticides available for use by APHIS include the U.S. Environmental Protection Agency (USEPA) registered chemicals carbaryl and diflubenzuron. These chemicals have varied modes of action. Carbaryl works by inhibiting acetylcholinesterase (enzymes involved in nerve impulses). Diflubenzuron inhibits the formation of chitin by insects which causes weak exoskeletons. APHIS would make a single application per year to a treatment area and could apply insecticide at an APHIS rate conventionally used for grasshopper suppression treatments, or more typically as reduced agent area treatments (RAATs). RAATs are the most common application method for all program insecticides, and only rarely do rangeland pest conditions warrant full coverage and higher rates. Full coverage and higher rates may be beneficial in areas with dense vegetation for the pesticide to have

the desired effect. Extremely high grasshopper densities and the need for higher grasshopper mortality can also warrant full coverage and higher rates. Even so, full coverage and higher rates is an unlikely scenario due to the extra expenses it would incur compared to the RAATs option.

APHIS selects which insecticides and rates are appropriate for suppression of a grasshopper outbreak based on several biological, logistical, environmental, and economical criteria. The primary biological factor is the grasshopper species and the most common life stage of the dominant species of concern. When grasshopper populations are mostly comprised of the first three instars diflubenzuron is typically selected because it is effective, economical and least harmful to non-target species. Diflubenzuron limits the formation of chitin in arthropod exoskeletons and can produce 90 to 97% grasshopper mortality in nascent populations with a greater percentage of early instars. If the window for the use of diflubenzuron closes, as a result of treatment delays, then carbaryl is the remaining control option. Carbaryl liquid would be considered if the majority of the insects were in later instars or adults. The circumstances where the use carbaryl bait would be best are reduced because of the higher cost per acre than liquid insecticide formulations. Only certain species consume carbaryl insecticide when it is formulated as a bait and their migratory or banding behavior allows targeted treatments over smaller areas. Some examples of species that meet these criteria are clearwinged grasshopper (*Camnula pellucida*) and Mormon crickets (*Anabrus simplex*).

The RAATs strategy is effective for grasshopper suppression because the insecticide controls grasshoppers within treated swaths while conserving grasshopper predators and parasites in swaths not directly treated. RAATs can decrease the rate of insecticide applied by either using lower insecticide concentrations or decreasing the deposition of insecticide applied by alternating treated and untreated swaths. Typically, program managers choose both options to lower the total amount of insecticide applied and treatment costs. Either carbaryl or diflubenzuron would be considered under this alternative, typically at the following application rates ((Lockwood et al., 2000, Foster et al., 2000, USDA APHIS, 2019):

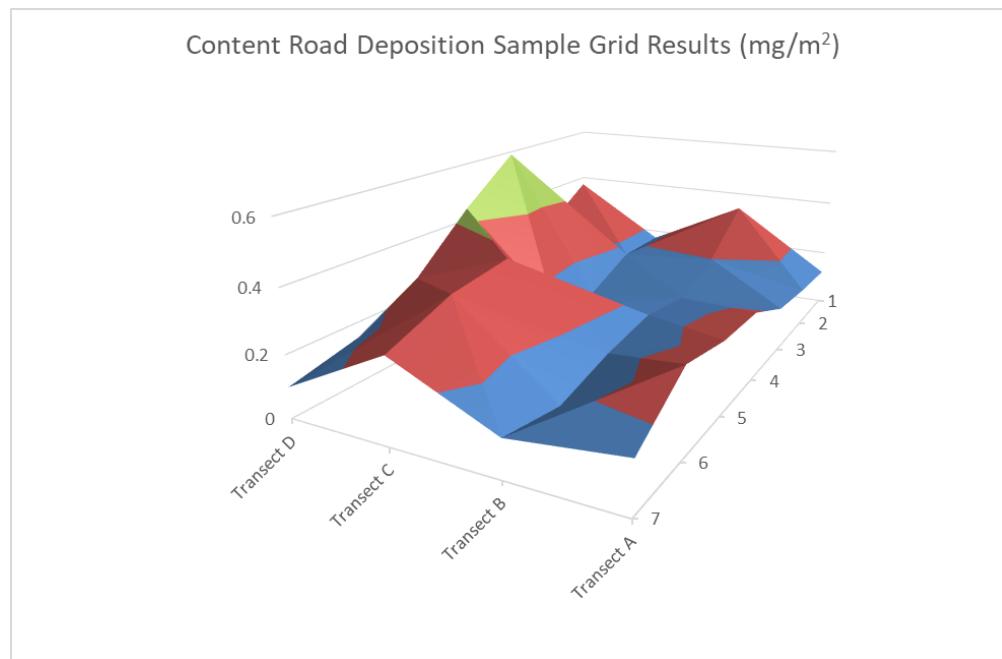
- 8.0 fluid ounces (0.25 lbs a.i./ac sprayed) of carbaryl spray;
- 10.0 pounds (0.20 lbs a.i./ac treated) of 2 percent carbaryl bait;
- 0.75 or 1.0 fluid ounce (0.012-0.016 lbs a.i./ac sprayed) of diflubenzuron

The width of the area not directly treated (the untreated swath) under the RAATs method is not standardized. The proportion of land treated during RAATs 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. Following the conventions and procedures established by these studies, 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 recommended skipped swath width is typically no more than 100 feet for carbaryl (liquid), and diflubenzuron. However, many Federal government-organized treatments of rangelands tend to prefer to use a 50% skipped swath width, meaning if a fixed-wing aircraft's swath width is, for example, 150 ft., then the skipped habitat area will

also be 150 ft. The selection of insecticide and the use of an associated swath widths is site dependent. Rather than suppress grasshopper populations to the greatest extent possible, the goal of this method is to suppress grasshopper populations to less than the economic injury level.

The variation in pesticide deposition resulting from following the RAATs procedures is not expected to result in chemical residues within the no spray swaths. Instead, swaths with maximum application rates alternate with swaths of low deposition rates. Program managers decided to increase the number of deposition dye card samples during 2021 to gather more data on actual application rates inside treatment blocks. Field personnel stationed 28 dye cards in a 150-foot spaced grid with four transects of seven cards. The long axis of the grid was oriented approximately parallel with the direction the aircraft were flying during the treatment. Unfortunately, strong winds caused pesticide drift from the flight swaths that were sprayed to the unsprayed swaths. Shortly after the portion of the treatment block containing the dye card grid was sprayed, the program managers ceased operations for the morning because wind gusts were measured over ten miles per hour. Figure 3 is a graph showing the pesticide concentrations on the dye cards as they were positioned in the grid. Despite the strong winds, the linear variation in deposition during an application using the RAAT method is evident. The program diflubenzuron application rate is 1.0 fluid ounce per acre which is equivalent to  $1.75 \text{ mg/m}^2$ , approximately three times greater than the highest dye card concentration.

*Figure 3. Diflubenzuron concentration on dye cards placed 150 feet apart in a grid*



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). 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 total area insecticide application) at a significantly lower cost and less insecticide, and with a markedly higher

abundance of non-target organisms following application (Deneke and Keyser, 2011; Lockwood et al., 2000). 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).

Insecticide applications at conventional rates and complete area coverage, is an approach that APHIS has used in the past but is currently uncommon because RAATs treatments use less insecticide and take less time to treat the same area resulting in substantial cost savings. Under this alternative, carbaryl or diflubenzuron would cover all treatable sites within the designated treatment block per maximum treatment rates following label directions:

- 16.0 fluid ounces (0.50 lbs a.i./ac sprayed) of carbaryl spray;
- 4.0 pounds (0.20 lbs a.i./ac treated) of 5 percent carbaryl bait;
- 1.0 fluid ounce (0.016 lbs a.i./ac sprayed) of diflubenzuron

The generalized potential environmental effects of the application of carbaryl and diflubenzuron under this alternative are discussed in detail in the 2019 EIS. A description of anticipated site-specific impacts from this alternative may be found in Part IV of this EA.

## ***B. Protective Measures and Program Procedures to Avoid or Reduce Adverse Impacts***

The Program applies insecticides as liquid ultra-low volume (ULV) sprays or solid-based carbaryl baits through aerial or ground applications. 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). Aerial applications are typical for treatments over large and less accessible areas. 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.

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 carbaryl, making it less bioavailable, particularly in dermal exposures (USDA APHIS, 2015). Biodegradation of carbaryl 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 use lower than the conventional label rates, specifically 0.5 gallon or less per acre of insecticide in liquid form. Liquid applications typically produce a quicker, greater, 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). The program avoids off target drift to protect

environmentally sensitive areas and maintain treatment efficacy. Various spray carriers and adjuvants minimize off-target movement of ULV sprays including synthetic or natural oils (e.g., canola oil).

As discussed in the previous section, the RAATs strategy reduces the treatment area, the application rate of insecticides, or both. RAATs methods suppress grasshopper populations below the economic injury level, rather than to the greatest extent possible, keeping with the IPM principles that have governed the program since the 1980s. 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. 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).

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 to protect 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. Environmental monitoring and flight line review are conducted daily during treatments to ensure accurate applications and buffering, as well as appropriate pesticide specifications and rates.

The program has procedures to limit potential movement of applied insecticides outside of the intended treatment area. Operationally, the accurate placement of the ULV spray insecticide is essential if grasshopper populations are to be suppressed efficaciously. Winds may displace the insecticide, and high air temperatures combined with low humidity may cause fine droplets to evaporate and drift without reaching the targeted vegetation. During applications, APHIS personnel constantly monitor wind conditions because when steady wind speeds exceed 10 miles per hour (mph), or wind direction changes towards sensitive habitat treatments are suspended until conditions improve. Field personnel measure ground and air temperatures to check for temperature inversions characterized by stable air with little mixing. Temperature inversions can cause ULV spray droplets to remain aloft increasing the potential for off-site transport of drift.

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 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).

GPS shapefiles showing exact treatment block boundaries and sensitive site buffers are provided to contracted applicators or to APHIS staff conducting treatments prior to start of operations, and blocks designated for treatment are inspected for unexpected sensitive sites and waterbodies to ground truth these maps. Dye cards are placed around sensitive sites to detect drift into buffer areas and aircraft are observed by binoculars during treatments to ensure deposition is at the expected rate and locations.

### **III. Environmental Consequences**

Chapter III identifies the affected environment where the Program will be implemented, identifies the types of impacts or effects that will be evaluated, and the environmental issues that will be studied. Each environmental issue section addresses a separate environmental resource, and includes background information, an evaluation of the impacts on those resources, and a conclusion. The alternatives are compared with the environmental consequences of the proposed action at the end of each issue section. Determination of significance of the impacts predicted in this chapter does not occur in this EA, but is made by the APHIS decisionmaker documented in the appropriate decision document.

#### ***A. Description of Affected Environment***

The proposed suppression program area included in the EA encompasses Moffat, Rio Blanco and Routt counties in Colorado. The size of this region is approximately 10,329 square miles within northwestern Colorado. This area encompasses geographically diverse terrain within multiple ecoregions including the Wyoming Basin, Colorado Plateau and the Southern Rockies.

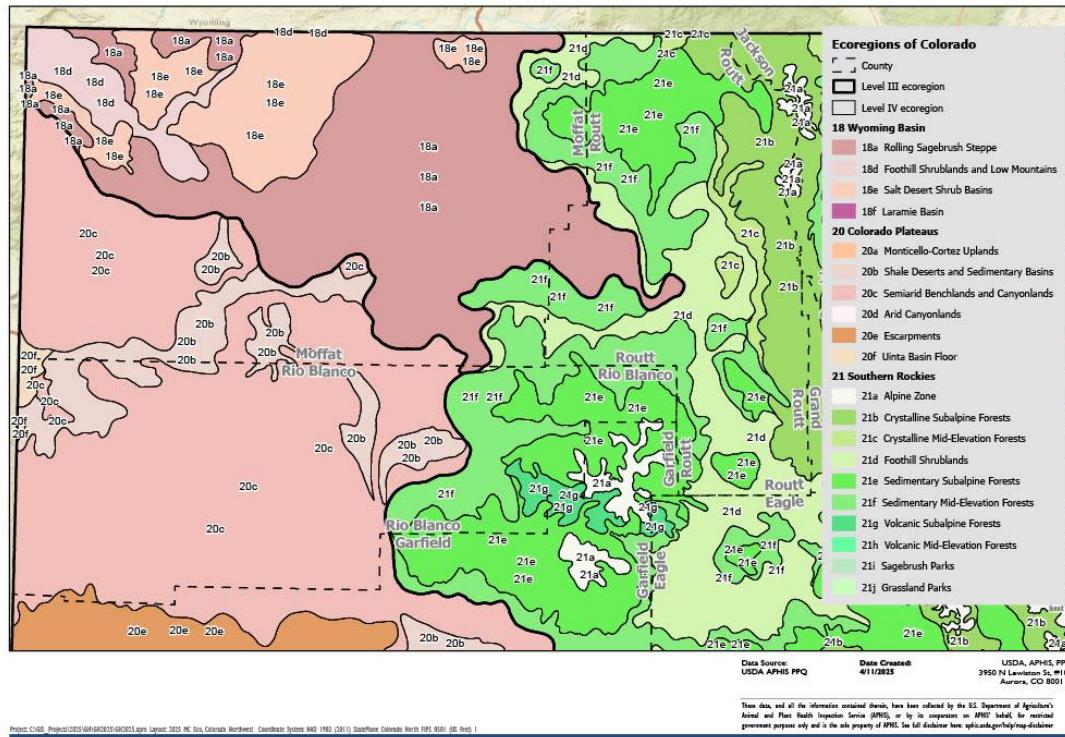


Figure 4. Northwest Colorado Ecoregions Map

**Wyoming Basin (18):** This ecoregion is a broad intermontane basin, interrupted by high hills and low mountains, and dominated by relatively arid grasslands and shrublands. Nearly surrounded by forest-covered mountains, the region is somewhat drier than the Northwestern Great Plains to the northeast and lacks the extensive cover of pinyon-juniper woodland found in the Colorado Plateaus to the south. Much of the region is used for livestock grazing. The region contains major natural gas and petroleum producing fields. The Wyoming Basin also has extensive coal deposits along with areas of trona, bentonite, clay, and uranium mining.

**Colorado Plateaus (20):** Canyons, mesas, plateaus, and mountains of the Colorado Plateaus expose a long geologic history of rock formations in Colorado. Rugged tableland topography is typical of the ecoregion. Precipitous side-walls mark abrupt changes in local relief, often of 1000 to 2000 feet or more. The region contains more pinyon-juniper and Gambel oak woodlands than the Wyoming Basin to the north. However, the Colorado Plateaus ecoregion also has large low-lying areas containing saltbrush and greasewood (typical of hotter, drier areas) which are generally not found in the Arizona/New Mexico Plateau to the south where grasslands are more common.

**Southern Rockies (21):** The Southern Rockies are composed of high elevation, steep, rugged mountains. Although coniferous forests cover much of the region, as in most of the mountainous regions in the western United States, vegetation, as well as soil and land use, follows a pattern of elevational banding. The lowest elevations are generally grass or shrub

covered and heavily grazed. Low to middle elevations are also grazed and covered by a variety of vegetation types including Douglas-fir, ponderosa pine, aspen, and juniper-oak woodlands. Middle to high elevations are largely covered by coniferous forests and have little grazing activity. The highest elevations have alpine characteristics.

Approximately 59% of the land within the tri-county area is classified as federal (Bureau of Land Management (BLM), U.S. Forest Service (USDA FS), U.S. Fish and Wildlife Service (USFWS), U.S. Department of Interior (DOI)) with the remainder being state and private lands. Elevations range from well over 10,000 ft. in the mountains to a low of approximately 5,000 ft. along the Green and Yampa Rivers.

The proposed treatment area for a rangeland grasshopper suppression program would be confined to specific areas requested by the land managers, within grasshopper habitat. These lands may include national monuments administered by the DOI, lands administered by the BLM, state lands, county lands or private lands. Target areas for any grasshopper treatment include sage/grass rangeland mixed with various native grasses, forbs, and shrubs.

The largest community within this three-county region is Steamboat Springs with a population of ~13,500 which is located in Routt County with a population of ~25,000. Other larger communities within the area include Craig with a population of ~9,000 (Moffat county, population ~13,000); Rangely with a population of ~2,300 (Rio Blanco county, population ~6,600); Meeker with a population of ~2,300 (Rio Blanco county ~2,300); Hayden with a population of ~1,900 (Routt county).

Major waterways include, but are not limited to: Green River, Yampa River and White Rivers. In addition, there are other important smaller streams. Lakes and Reservoirs include: Elkhead Reservoir, Kenney Reservoir, Lake Avery (Big Beaver Reservoir), Lake Catamount, Pearl Lake, Rio Blanco Lake, Stagecoach Reservoir, Steamboat Lake, and others. In an APHIS grasshopper suppression program, no waterways will be treated. Proper buffer zones will be adhered to.

Local natural attractions include Dinosaur National Monument Browns Park National Wildlife Refuge, White River and Routt National Forests, and multiple State Parks.

## ***B. Special Management Areas***

APHIS is aware there are areas that have greater scenic and environmental value within the rangeland areas considered by this EA. These areas might have remote recreational uses, special ecological characteristics or species that are of special concern to land management agencies, the public, or other groups and individuals. APHIS only conducts treatments when requested by land managers and where treatments are warranted. APHIS does not treat areas that land managers request excluded. APHIS and land managers identify and exclude Wilderness Study Areas and areas of Critical Environmental Concern. Critical habitat areas and federally protected species are discussed, and mitigations measures are addressed in the Revised Biological Assessment for the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program (January 2024). .

### ***C. Effects Evaluated***

Chapter III examines the direct, indirect, and cumulative effects of each of the alternatives on the biological, physical, and sociocultural aspects of the human environment (issues). Direct effects are caused by the action and occur at the same time and place (40 CFR § 1508.1(i)(1)). Indirect effects are caused by the action but are later in time and farther removed in distance (40 CFR § 1508.1(i)(2)). Cumulative effects are the effects on the environment that result from the incremental effects of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency or person undertakes such other actions (40 CFR § 1508.1(i)(3)). Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.1(i)(3)).

Cumulative impact, as defined in the Council on Environmental Quality (CEQ) NEPA implementing regulations (40 CFR § 1508.1) “is the impact on the environment which results from the incremental impact of the action when added to the past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.”

Potential cumulative impacts associated with the No Action alternative where APHIS would not take part in any grasshopper suppression program include the continued increase in grasshopper populations and potential expansion of populations into neighboring range and cropland. In addition, State and private land managers could apply insecticides to manage grasshopper populations however, land managers may opt not to use RAATs, which would increase insecticides applied to the rangeland. Increased insecticide applications from the lack of coordination or foregoing RAATs methods could increase the exposure risk to non-target species. In addition, land managers may not employ the extra program measures designed to reduce exposure to the public and the environment to insecticides.

Potential cumulative impacts associated with the Preferred Alternative are not expected to be significant because the program applies an insecticide application once during a treatment season. 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. No APHIS treatments were conducted in Colorado in 2024. 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.

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. Other groups/agencies have conducted small-scale

Mormon cricket treatments in Moffat and Rio Blanco counties in recent years, and those treatments are expected to continue in future years. County Weed and Pest Districts and Conservation Districts have contracted aerial treatment with Diflubenzuron and Lamcap on private land. County Weed and Pest Districts and Bureau of Land Management have contracted diflubenzuron treatments on federal land (BLM). Private landowners have applied carbaryl bait to their private land. For any APHIS treatments, APHIS will coordinate with all land managers to ensure that treatment areas do not overlap, which will make cumulative impacts unlikely. Other non-APHIS pesticide application activities may or may not take place in the vicinity of grasshopper suppression treatment areas. They may be undertaken by private applicators, members of the public, or state and county governments for a variety of reasons and without APHIS involvement. For instance, typically, mosquito control programs are an example of an activity where pesticide application is conducted in areas outside of grasshopper suppression areas, such as towns. These treatments are conducted by county-personnel, not APHIS personnel. Mosquito abatement programs and their operations vary throughout Colorado, but generally treatments are conducted in the early morning or late night when pollinators are not active.

Potential cumulative impacts resulting from the use of pesticides include insecticide resistance, synergistic chemical effects, chemical persistence and bioaccumulation in the environment. The program use of reduced insecticide application rates (i.e. ULV and RAATs) are expected 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 further eliminating the selection pressure that increases the chances of insecticide resistance.

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. However, the vast majority of the land where program treatments occur is uncultivated rangeland and additional treatments by landowners or managers are very uncommon making possible cumulative or synergistic chemical effects extremely unlikely.

APHIS has prepared this EA for Moffat, Rio Blanco and Routt counties in Colorado because treatments could be requested if grasshopper populations reach outbreak levels. Past experience and continuing high grasshopper/Mormon cricket population conditions lead APHIS to believe treatments will be needed in the near future. Unfortunately, the agency can't accurately predict exact treatment locations and usually discovers building grasshopper populations only a few weeks in advance. Additionally, requested treatments may be cancelled or change location if land manager priorities and policies shift, APHIS funding and staffing is too limited, or higher priority work emerge. Thunderstorms, heat waves or wildfires may also make areas inaccessible or delay treatments past the optimal window.

No APHIS treatments have been conducted in Colorado for over 15 years. Mormon cricket populations continue to expand in Moffat and Rio Blanco counties since 2020. See Appendix B: Map of the Affected Environment for areas where Mormon crickets were observed during the APHIS 2025 survey.

## ***D. Site Specific Considerations and Environmental Issues***

Environmental issues are the resources that may be affected by the proposal, or concerns about the risks to humans from implementing the Program. The following issues are analyzed in Section E. Environmental Consequences of the Alternatives in the order outlined.

### **1. Human Health**

Direct exposure of humans to program chemicals because of suppression treatments is unlikely due to the infrequency of treatments and the general lack of humans in treatment areas. In addition, program buffers and procedures further reduce the chances of human exposure. Additionally, pesticide label specifications, standard spill prevention and rapid response measures mitigate the risk of accidental human exposure resulting from program activities.

A buffer of 1.25 miles from the treatment area to the perimeter of any town and other communities will be used. Ranch buildings and structures (such as stock tanks) will have a buffer of 200 feet. Federal highways and State roads will have a buffer of 25 feet. Local law enforcement, fire departments emergency medical services, hospitals and tribal agencies will be notified prior to any treatment as an advisory to access any safety risk, the treatment date and location and contact personnel.

The suppression program would be conducted on federally managed rangelands that are not inhabited by humans. Human habitation may occur on the edges of the rangeland. Most habitation is comprised of farm or ranch houses, but some rangeland areas may have suburban developments nearby. Average population density in rural areas of the area considered by this EA is between 2 and 2.8 persons per square mile (United States Census Bureau, 2020).

Recreationists may use the rangelands for hiking, camping, bird watching, hunting, falconry or other uses. Ranchers and sheepherders may work on the rangelands daily. Individuals with allergic or hypersensitive reactions to insecticides may live near or may utilize rangelands in the proposed suppression program area. Some rural schools may be in areas near the rangeland which might be included in treatment blocks. Children may visit areas near treatment blocks or may even enter treatment blocks before or after treatments.

The 2019 EIS contains detailed hazard, exposure, and risk analyses for the chemicals available to APHIS. Impacts to workers and the general public were analyzed for all possible routes of exposure (dermal, oral, inhalation) under a range of conditions designed to overestimate risk. The operational procedures and spraying conditions examined in those analyses conform to those expected for operations.

Direct exposure to program chemicals as a result of suppression treatments is unlikely due to the infrequency of treatments and the general lack of humans in treatment areas. In addition, program buffers and procedures further reduce the chances of human exposure. Finally, pesticide label specifications, standard spill prevention and rapid response measures mitigate the risk of accidental human exposure resulting from program activities.

Potential exposures to the general public from conventional application rates are infrequent and of low magnitude. The RAATs approach reduces this potential even further by using reduced rates and less actual directly treated area. The proposed program should benefit human and environmental health by reducing the risk of insect annoyance, blowing dust, higher light reflection and higher temperature on the semi-arid land surface.

Various compounds are released in smoke during wildland fires, including carbon monoxide (CO), carbon dioxide, nitrous oxides, sulfur dioxide, hydrogen chloride, aerosols, polynuclear aromatic hydrocarbons 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).

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>).

The safety data sheet for each insecticide identifies these combustion products as well as recommendations for personal protective equipment (PPE) which is equal 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. Therefore, the PPE worn by rangeland firefighters would also be protective of any additional exposure resulting from the burning of residual insecticides.

## 2. Nontarget Species

While the program conducts grasshopper control treatments any other species affected by the insecticides can be viewed as non-target effects or unintentional take. The program has established and follows procedures to prevent take of species federally listed under the Endangered Species Act as endangered or threatened. The programmatic protection measures that resulted from consultation with the Services also prevent take of state listed species (sensitive species or species of concern) in the same habitats or having similar ecological (i.e., the relationship between species and their environment) niches as federal listed species. These procedures (e.g., no-spray buffers, RAATs, insecticide choices) also limit effects on pollinators (e.g., butterflies, moths, bees) and other beneficial insects.

NEPA requires agencies to use “high-quality information, including reliable data and resources, models, and Indigenous Knowledge. Agencies may rely on existing information as well as information obtained to inform the analysis. Agencies may use any reliable data sources, such as remotely gathered information or statistical models. Agencies shall explain any relevant assumptions or limitations of the information, or the particular model or methodology selected for use.” 40 C.F.R. § 1506.6(b). In Colorado, the Colorado Natural

Heritage Program (CNHP) is a source of information on the status and location of Colorado rare and imperiled species and natural plant communities.

Estimating nontarget species population sizes over large areas can be extremely difficult, labor intensive, and expensive. State and federal wildlife management agencies have limited resources to conduct flora and fauna population surveys and monitor trends. States may monitor the status of wildlife populations by assessing sex ratios and age distribution. Plant species surveys often identify historical or potential habitat locations. In accordance with CEQ regulations and to preserve the professional and scientific integrity of the analysis, this EA uses reliable existing data and resources provided by jurisdictional agencies and peer-reviewed literature to estimate nontarget species population sizes.

To estimate population size for these species, conservative estimates are derived from the best available density estimates reported in the literature, with preference given to publications and studies in Colorado or states having similar habitat. Density estimates may be for adults or all age classes. Population estimates based on potential habitat includes further extrapolation and speculation. The lowest estimate is assumed to be the minimum population. Habitat suitability indices, localized density fluctuations, and immigration or emigration are may not be factored into these calculations, nor is density based on quantity of habitat. All population estimates are considered to be conservative, as we have used the lowest population estimate among the ranges of those available in the literature. The program suppresses grasshopper populations on a small portion of the area considered by this EA in any given year. In those control treatment areas substantial portions are excluded from direct insecticide applications because of buffers around sensitive sites and the alternating spray and skip swaths inherent in the RAATs method. Thus, the potential impacts from the program activities on nontarget species populations occur in a small portion of the area considered by this EA and for a limited duration.

According to USDA's Natural Resource Conservation Service (NRCS), rangelands comprise about 30% of the entire land cover of the United States, totaling about 770 million acres. These lands are described by the NRCS as lands on which the indigenous vegetation is predominately grasses, grass-like plants, forbs, and possibly shrubs or dispersed trees, containing plant communities of either native or introduced plants. Grasslands, open forest, shrublands and associated wetlands are most likely to host outbreaks of grasshoppers and be targeted for suppression programs. These lands host abundant and diverse terrestrial and aquatic organisms.

Based on the available scientific research, there is a decrease in quantity of pollinators across the country and in rangeland ecosystems. However, the extent of program insecticide's role in this decrease is not clear. Existing research serves to outline the impact of these pesticides on pollinators of the order Hymenoptera and Lepidoptera primarily but also delves into pollinators of other orders to a lesser extent.

The availability of native floral resources is a primary determinant of the composition and abundance of bees and other pollinators in rangeland ecosystems in the United States (Potts et al. 2003, Gilgert and Vaughan 2011, Tuell et al. 2014). Approximately 4,000 different bee species aid in pollination in the United States (Black et al. 2011, Gilgert and Vaughan 2011). Many secondary pollinators such as moths and butterflies, wasps, flies, and beetles

also contribute to distributing pollen despite being less efficient than bees (Larson et al. 2018).

According to Goosey et al., rangeland ecosystems are primarily pollinated by bee species. At 27 pastures in central Montana specimens from 27, 24, and 16 different bee genera were captured during 2016, 2017, and 2018, respectively. *Lasioglossum* (*Dialictus*), *Agapostemon*, and *Eucera* were the most common genera captured constituting more than half (58%) of bee specimens. *Halictus* was the fourth most common genera, adding another 7% to the total bee capture. In 2016, secondary pollinators were ~8% of total pollinator catch. Lepidopterans were 10-fold more abundant than Syrphidae as secondary pollinators across all years. Secondary pollinators were 19% and 13% of the total catch in 2017 and 2018, respectively.

Furthermore, the researchers found in 2016 and 2017 bee abundance increased where periodic grazing of pastures provided suitable nesting habitat for these rangeland pollinators. They suggested forage consumption and hoof action likely created the unvegetated space required for reproduction by these mostly solitary, ground-nesting bees. However, abundances of secondary pollinators (i.e., butterflies and hover flies) were unrelated to grazing during two of the three study years. According to Gilgert and Vaughan, the diverse plant landscapes that rangelands are composed meet the needs of a variety of pollinators, including Hymenopterans and Lepidopterans. Idling large swaths of rangelands could be detrimental to bee populations because most ground-nesting species exhibit breeding-site fidelity, with multiple generations returning to nest in the same pasture (Michener 2007).

The Xerces society promotes a symbiotic relationship between pollinators and rangelands, with each benefitting from the others existence (Buxton et al.). Noting rangelands provide large contiguous areas of food and shelter habitat for pollinators. Likewise, the pollination of a wide array of wildflowers produces valuable forage for cattle and wildlife, supports soil health, and makes grasslands more resilient. Information about rangeland pollinators species is generally limited, with most of it coming from “uncoordinated, short-term, small-scale sampling focusing on bees and butterflies” (Hanberry et al.). Though this information is limited, studies on bees of the Great Plains indicate that about two-thirds of the bee species in rangelands are generalists, which use many families of plants for nectar and nesting. With this information about generalist nature of bees in rangelands, and the increased biodiversity caused by grazing, pollinators of the rangelands are very likely widespread in both species and location, which can increase their resiliency to disturbances.

Therefore, pesticides applications will also potentially impact a much more abundant and rich collection of pollinators due to the unique qualities of rangeland habitats. Additionally, the presence of agrochemicals and other pesticides have been found in samples of bee tissue from the Great Plains, likely due to the conversion of land from pollinator friendly rangeland to crop fields (Hladik et al 2016, Otto et al 2016).

According to a sampling of native bees communities across broad Canadian ecoregions Kohler et al, found climate and geographic variables caused differences in species

abundance, richness, and composition, indicating that assessments on impacts may not be generalizable across the entire rangeland ecosystem. The researchers found bee community composition was significantly different across regions (i.e., Canadian grassland, parkland and boreal areas) and between land use types (i.e., rangeland and canola cropland). Within rangeland communities it may be difficult to understand the best conservation measures for bees due to the variance in responses on a larger scale.

Colorado, a state that is approximately 60% rangeland, has a diverse landscape of plants and pollinators. Its diverse community of native pollinators consists of over 900 species of native bees (Scott et al., 2011) and numerous species of butterflies and moths, wasps, beetles and flies.

Biodiversity of invertebrate organisms is crucial for ecosystem health. Biocontrol insects and pollinators in particular help control noxious weeds and provide pollination services crucial to sustaining diverse ecosystems. Pollinators include managed exotic species such as European honeybees and a huge diversity of native species including many kinds of solitary and eusocial bees, wasps and ants, flies, hoverflies and bee-mimicking flies, many families of beetles, true bugs, moths and butterflies among others. In addition to general pollination services, some species of insects are obligate pollinators of rare plants, meaning the plants cannot reproduce without them. Other services which both terrestrial and aquatic invertebrates provide are less obvious but equally important, including nutrient cycling, decomposition and stimulating plant regrowth. Many species of herbivorous insects including grasshoppers are in this general category. Predacious invertebrates (e.g. arachnids, mantids, and dragonflies) help regulate herbivores while also providing food to larger animals. Invertebrates in general are incredibly important to ecosystem health, and provide the greatest animal biodiversity within these ecosystems.

One non-target invertebrate species of potential concern, which have been previously brought up in public scoping for the program is the monarch butterfly (*Danaus plexippus*). The monarch butterfly may potentially be found throughout Moffat, Rio Blanco and Routt counties in Colorado and is being considered for ESA protections. Though not rare, milkweed plants (which support monarch butterfly) would be an example of a plant species that would be desirable to buffer, as requested by any land manager involved. The [Western Monarch Milkweed Project](#) is part of a collaborative effort to map and better understand monarch butterflies and their host plants across the Western U.S. This site can be cross referenced with proposed treatment areas to alert the program of any monarch activity or host plants in the area, <https://www.monarchmilkweedmapper.org>. Due to methods and materials, impacts to flowering plants, including pollination services, are not anticipated to be significant by proposed actions, except for the no action alternative, which may result in fewer such plants due to herbivory by damaging grasshopper population outbreaks.

The area assessed by this EA includes a variety of organisms i.e., terrestrial vertebrates and invertebrates, migratory birds, biocontrol agents, pollinators, aquatic organisms, plants (both native and introduced), etc. APHIS will employ measures, such as buffer zones, to protect these species and their habitat. APHIS will also consult with local agency officials to determine appropriate protective measures.

Vertebrates occurring in rangelands of the area covered by this EA include introduced livestock and pets (e.g. cows, goats, sheep, horses, poultry, cats, dogs) and native species including carnivores (e.g. coyotes, foxes, wolves, mountain lions), large herbivorous mammals (e.g. deer, elk, pronghorn), smaller ones (e.g. rabbits, gophers), omnivores (e.g. badgers, mice, bats).

Many reptile species are known to inhabit the area covered by this EA including lizards and snakes. Some lizards found in the area include the Sagebrush Lizard and the Greater Short-horned Lizard. Snakes potentially found in the area include the Prairie Rattlesnake, Gopher Snake and Smooth Greensnake. Some amphibians include the American bullfrog and Woodhouse's toad.

Some common fish species found in this 3-county area include trout (rainbow, brown, and cutthroat), northern pike, and bass (smallmouth and largemouth). Other common species found in the area include channel catfish, walleye, bluegill, crappie, and sunfish.

Birds comprise a large portion of the vertebrate species complex, and they also include exotic and native species. Some exotic game birds, like pheasants and chukars, have been deliberately introduced into the area, and other species such as starlings and pigeons have spread from other locations of introduction. Sage-obligate bird species, typified by greater sage grouse, are present in areas of Moffat, Rio Blanco and Routt counties. Herbivorous vertebrate species compete with some species of grasshoppers for forage, while omnivorous and predacious species utilize grasshoppers and other insects as an important food source. Predacious species that feed on grasshoppers have varied diets and can find other food sources in the event that treatments drastically reduce grasshopper numbers. Most of the migratory and yearly birds that inhabit the program area are classified as least concern, meaning their population size and trends are above the vulnerable threshold. Accurate population estimates for bird species that inhabit the program area are unavailable. Program mitigation measures such as the RAATs method and ULV applications reduce the effects program pesticides might have on birds in the program area.

A diverse community of terrestrial plants occurs within the proposed suppression area. Many are considered as non-native, invasive weeds including annual grasses (e.g. cheat grass), annual forbs (e.g. diffuse knapweed, Scotch thistle, Dalmatian toadflax), perennial forbs (e.g. Canada thistle, Russian thistle, white top), and woody plants (e.g. Russian olive, tamarisk). A full complement of native plants (e.g. sagebrush, bitterbrush, numerous grasses and forbs) have coevolved with and provide habitat for native and domesticated animal species, while providing broad ecological services, such as stabilizing soil against erosion.

Biological soil crusts, also known as cryptogamic, microbiotic, cryptobiotic, and microphytic crusts, occur within the proposed suppression area. Biological soil crusts are formed by living organisms and their by-products, creating a crust of soil particles bound together by organic materials. Crusts are predominantly composed of cyanobacteria (formerly blue-green algae), green and brown algae, mosses, and lichens. Liverworts, fungi, and bacteria can also be important components. Crusts contribute to various functions in the environment. Because they are concentrated in the top 1 to 4 mm of soil, they primarily affect processes that occur at the land surface or soil-air interface. These include stabilizing

soil against erosion, fixing atmospheric nitrogen, providing nutrients to plants, and improving soil-plant-water relations, infiltration, seedling germination, and plant growth.

Finally, sundry other organisms (e.g. fungi and fungus-like organisms, algae and lichens, non-vascular plants, earthworms and other annelids, both terrestrial and aquatic microorganisms) are often less visible in rangelands within the scope of this EA but are nonetheless present and contribute to these ecosystems in various ways.

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 species or result in the destruction or adverse modification of critical habitat. Within the area under consideration by this EA there are sixteen federally listed species and four areas of designated critical habitat, although not all occur within or near potential grasshopper suppression areas.

Endangered species which may occur in the program area include Whooping crane (*Grus americana*), Bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), Pallid sturgeon (*Scaphirhynchus albus*), and Razorback sucker (*Xyrauchen texanus*). Threatened species include Canada lynx (*Lynx canadensis*), Mexican spotted owl (*Strix occidentalis lucida*), Yellow-billed cuckoo (*Coccyzus americanus*), Humpback chub (*Gila cypha*), Silverspot (*Speyeria nokomis nokomis*), Dudley bluffs bladderpod (*Lesquerella congesta*), Dudley bluffs twinpod (*Physaria obcordata*), Parachute beardtongue (*Penstemon debilis*), Ute Ladies'-tresses (*Spiranthes diluvialis*), and Western prairie fringed orchid (*Platanthera praecox*). There is also an Experimental Non-essential population of Gray wolf (*Canis lupus*).

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.

APHIS submitted a programmatic biological assessment for grasshopper suppression in the 17-state program area and requested consultation with USFWS on March 9, 2015. In November 2023 APHIS revised the biological assessment to address USFWS comments and include species that had been listed since 2015. USFWS concurred with APHIS' determination the grasshopper program would have no effect or was not likely to adversely affect listed species and the critical habitat on March 21, 2024. USFWS stated:

“As a result of the APHIS program conservation measures such as use of the buffer distances discussed above for all taxonomic groups and their designated critical habitats, as applicable, along with the reduced application rates as compared to label rates for each insecticide, and RAAT treatment procedures, any risk of exposure associated with the application of the three insecticides used under the APHIS grasshopper and Mormon cricket suppression program is expected to be minimal. Thus, any direct or indirect effects from the proposed action to listed species and their designated

critical habitats are expected to be insignificant due to program conservation measures.”

For the threatened and endangered species listed in this program area, in the programmatic biological assessment APHIS has determined that the grasshopper program will have no effect on the Canada lynx and Silverspot. APHIS has determined that with the implementation of protection measures, the grasshopper program may affect but is not likely to adversely affect the Mexican spotted owl, Whooping crane, Yellow-billed cuckoo, Bonytail, Colorado pikeminnow, Humpback chub, Pallid sturgeon, Razorback sucker, Dudley Bluffs bladderpod, Dudley Bluffs twinpod, Parachute beardtongue, Ute Ladies'-tresses and Western prairie fringed orchid, and their designated critical habitats. A summary table of protection measures can be found in Appendix C of this document. APHIS will also continue to consult with USFWS field offices at the local level to ensure listed species habitats are properly buffered during grasshopper suppression treatments.

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 because of the listed salmonid (*Oncorhynchus* spp.) and critical habitat. 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 a 3,500 foot buffer zones for carbaryl or malathion, or applied within a 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.

APHIS considers the role of pollinators in any consultations conducted with the USFWS to protect federally listed plants. Mitigation measures, such as no treatment buffers are applied with consideration of the protection of pollinators that are important to a listed plant species.

The Migratory Bird Treaty Act 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.

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 reducing, 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.

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. 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. However, rangeland grasshopper suppression treatments occur during the late spring or early summer, after the nesting season when eagle young typically will have already fledged. The program also recognizes disruptive activities in or near eagle foraging areas can interfere with bald eagle feeding, reducing chances of survival. Program operational procedures that prevent applications near water bodies will reduce the possibility of disturbing eagle foraging activities. USFWS has provided recommendations for avoiding disturbance at foraging areas and communal roost sites that are applicable to grasshopper management programs (USFWS, 2007).

No toxic effects are anticipated on eagles as a direct consequence of insecticide treatments. Toxic effects on the principal 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.

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 populations have declined throughout most of their entire range, with habitat loss being a major factor in their decline.

There is special concern about the role of grasshoppers as a food source for sage grouse, and other bird species. Grasshopper suppression programs reduce grasshoppers and at least some other insects in the treatment area that can be a food item for those species including sage grouse chicks. As indicated in previous sections on impacts to birds, there is low potential that the program insecticides 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 they likely do in years when grasshopper numbers are naturally low. By suppressing grasshoppers, rangeland vegetation is available for use by other species, and

rangeland areas are less susceptible to invasive plants that may be undesirable for sage grouse and other species' habitat.

APHIS will work with BLM, state 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 to the public.

APHIS implements several best management practices in our treatment strategies that are designed to protect nontarget invertebrates, including pollinators. APHIS minimizes insecticide use by using lower than labeled rates for all program insecticides, alternating swaths during treatment, making only one application per season and minimizing use of liquid broad-spectrum insecticides. APHIS also continues to evaluate new monitoring and control methods designed to respond to economically damaging populations of grasshoppers and Mormon crickets while protecting rangeland resources such as pollinators.

### **3. Physical Environment Components**

#### **a) Geology and Soils**

Soils in this region can include heavy clay to well-drained sandy soils encompassing many characteristics including being shallow or deep, deficient or adequate in organic matter content, or high in salts—to name a few. Soil parameters, such as nutrient levels, are highly variable in this region.

Soil is the basic component of rangeland ecosystems and is associated with nearly all processes that occur within the ecosystem. It provides a medium to support plant growth. It is also the home for many insects and microorganisms. It is a product of parent material, climate, biological factors, topography, and time. The soil formation process is slow, especially in arid and semiarid climates. It is believed to take several hundred years to replace an inch of top soil lost by erosion. Rangeland soils, as those found in the Great Plains and Palouse Prairie, have been extensively converted to agricultural crop production. Remaining rangeland soils may be rocky, steep, salt affected, or otherwise not very productive compared to prime agricultural lands. The chemical and physical characteristics of a soil determine: its ability to furnish plant nutrients, the rate and depth of water penetration, and the amount of water the soil can hold and its availability to plants.

#### **b) Hydrology and Water Resources**

Major waterways in the areas covered by this EA include, but are not limited to: Green River, Yampa River and White Rivers. Lakes and Reservoirs include: Elkhead Reservoir, Kenney Reservoir, Lake Avery (Big Beaver Reservoir), Lake Catamount, Pearl Lake, Rio Blanco Lake, Stagecoach Reservoir and Steamboat Lake. Numerous other small streams, seasonal streams, reservoirs, lakes, ponds and stock ponds are located throughout the area.

#### **c) Air Quality and Climate**

The northwest region of Colorado affected by high grasshopper/Mormon cricket populations historically experiences a harsh, semi-arid climate with cold winters, hot summers, and low precipitation with an average yearly rainfall between 10 to 16 inches.

This makes the region prone to droughts and agricultural challenges reflected in a short growing season. Air quality is generally good but can be affected by seasonal dust storms and wildfires.

#### **4. Socioeconomic Issues**

Rangelands are essential to western livestock producers providing forage for a variety of domestic animals. Economic values of rangelands also include energy production sites, both fossil and renewable, and recreation sites. Two important distinctions are between market and non-market values, and between use and non-use values. Market values are associated with goods and services sold directly in a marketplace (e.g., livestock); market prices are therefore a good estimate value. Non-market values arise from goods and services that are not directly sold in a marketplace (e.g., ecosystem services). Similarly, use values arise from goods that are physically used (now or in the future), such as forage for livestock (market value) or outdoor recreation (usually a non-market value). Non-use values arise from goods that are never physically used. Non-use values, for example, include the concept of "existence value" (i.e., the value people place on simply knowing something, such as an unspoiled wilderness area, exists). Non-use values are often unrelated to any market good, but are real economic values nonetheless. Non-market and non-use values are difficult to estimate; therefore, most economic injury level estimates only consider market values and, in most cases, only the single market value for the commodity (e.g., forage) being damaged. In the case of rangeland, there are a large suite of values, both market and non-market, and use and non-use, that can be affected by pests, such as grasshoppers (Rashford et al., 2012).

The treatment of grasshoppers is expected to be of socioeconomic benefit to the community. Treatment areas are to include rangeland that if left untreated is expected to be devastated by high grasshopper populations. Grasshoppers are expected to defoliate the area causing loss of ground cover, loss of habitat, increased erosion, and increased run-off. In addition, grasshoppers may become a safety and nuisance pest. Protecting the rangeland from over consumption by grasshoppers would therefore benefit the livestock owners, crop growers, outdoor enthusiasts, and the general public.

#### **5. Cultural Resources and Events**

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. 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.

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.

To ensure that historical sites, monuments, buildings, artifacts or known areas of cultural events and/or observances of special concern are not adversely affected by program treatments, APHIS will confer locally with state and federal land managers on proposed treatment areas.

## **6. Special Considerations for Certain Populations**

### **a) Executive Order No. 13045, Protection of Children from Environmental Health Risks and Safety Risks**

The increased scientific knowledge about the environmental health risks and safety risks associated with hazardous substance exposures to children and recognition of these issues in Congress and Federal agencies brought about legislation and other requirements to protect the health and safety of children. On April 21, 1997, President Clinton signed E.O. 13045, Protection of Children From Environmental Health Risks and Safety Risks (62 FR 19885). This E.O. requires each Federal agency, consistent with its mission, to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that its policies, programs, activities, and standards address those risks. APHIS has developed agency guidance for its programs to follow to ensure the protection of children (USDA, APHIS, 1999). Grasshopper programs treatments are primarily conducted on open rangelands where children would not be expected to be present during treatment or enter during the restricted entry period after treatment.

## ***E. Environmental Consequences of the Alternatives***

Each alternative described in this EA potentially has adverse environmental effects. The general environmental impacts of each alternative are discussed in detail in the 2019 programmatic EIS published by APHIS. The specific impacts of the alternatives are highly dependent upon the particular action and location of the grasshopper infestation. The principal concerns associated with the alternatives are: (1) the potential effects of insecticides on human health (including subpopulations that might be at increased risk); and (2) impacts of insecticides on nontarget organisms (including threatened and endangered species).

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, non-target wildlife, and its environmental fate in soil, air, and water. The assessments rely on data required by USEPA for pesticide product registrations, as well as peer-reviewed and other published literature. The HHERAs are heavily referenced in the 2019 EIS and this

Draft is likewise tiered to that analysis (USDA APHIS, 2019a, 2019b, 2019c, 2019d). These Environmental Documents can be found at the following website: <http://www.aphis.usda.gov/plant-health/grasshopper>.

The program suppresses grasshopper populations on a small portion of the area considered by this EA in any given year. In those control treatment areas substantial portions are excluded from direct insecticide applications because of buffers around sensitive sites and the alternating spray and skip swaths inherent in the RAATs method. The potential harmful effects from the program activities on environmental components and nontarget species populations occur in a small portion of the area considered by this EA and for a limited duration. Site-specific environmental consequences of the alternatives are discussed below.

## **1. Alternative 1 - No Suppression Program Alternative**

### **a) Grasshopper Population Control**

Under this alternative, APHIS would not conduct a program to suppress grasshoppers other than provide technical assistance and surveys to assist in the implementation of IPM strategies by land managers. When cultural or mechanical methods have failed to prevent harmful grasshopper populations Federal land management agencies, State agriculture departments, local governments, private groups or individuals, may not effectively combat outbreaks in a coordinated effort. Without the coordination that APHIS provides during grasshopper outbreaks, the land managers and owners could use insecticides that APHIS considers too environmentally harsh. Multiple treatments and excessive amount of insecticide could be applied in efforts to suppress or even locally eradicate grasshopper populations. There are approximately 100 pesticide products registered by USEPA for use on rangelands and against grasshoppers (Purdue University, 2018).

Without APHIS' coordination and funding of grasshopper suppression programs in Colorado the responsibility would rest with BLM, Colorado Department of Agriculture, local governments, industry groups and private parties to coordinate and perform control treatments. The conventions of IPM APHIS has incorporated into our standard program procedures could be too burdensome for other agencies to observe. While the economic benefits of suppressing grasshoppers by using a RAATs method have been widely publicized, less frequent treatments by other agencies might encourage widespread complete coverage treatments to "eradicate" grasshopper populations. Adverse environmental effect particularly on nontarget species, could be much greater than under the APHIS led suppression program alternative due to lack of operational knowledge or coordination among the groups.

#### **(1) Human Health**

Human exposure and health risks could increase because of the inexperience of other agencies in planning, contracting and monitoring treatments. APHIS hygiene and safety protocols establish procedures for use of personal protection equipment and handling of hazardous chemicals. Other less experienced agencies might underestimate potential worker or bystander exposures, increasing health risks.

#### **(2) Nontarget Species**

Grasshopper treatment programs could occur with more random frequency as various agencies allocate funding when it is available. These programs would almost certainly not have the same procedures and safeguards incorporated into the APHIS program. The possibility of multiple agencies with overlapping jurisdictions could result in multiple treatments per year with the same or incompatible insecticides. This overlapping of treatments could cause synergistic chemical interactions and more severe effects to nontarget species. It is also unlikely the other agencies will be equally equipped as APHIS to incorporate guidance and species location information from USFWS. Therefore, adverse effects on protected species and their critical habitat could increase.

### ***(3) Physical Environment Components***

The potential grasshopper control conducted by third parties could result in increases and a greater variety of pesticide residues in the environment. As noted previously, APHIS can only speculate which agencies and land owners will decide to control grasshoppers and what chemicals will be used. 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 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). Almost certainly land management agencies and property owners would not observe the same buffers to prevent accidental spray drift to sensitive environments.

### ***(4) Socioeconomic Issues***

In the absence of an APHIS administered grasshopper suppression program the cost of treatments would be paid entirely by land management agencies and land owners. Ranchers that lease land for grazing livestock might also have to pay third parties to protect rangeland forage from grasshopper outbreaks. These additional expenses would increase the cost of rangeland leases and production of livestock in general. Rural economies that depend on ranching and farming would experience increased economic hardship. The economic effects of infrequent and haphazard grasshopper treatments on rangeland forage could be similar to those described below for a scenario where no treatments occur.

### ***(5) Cultural Resources and Events***

The potential grasshopper control conducted by third parties might or might not be coordinated with Tribes and other cultural or historical observance events. It is reasonable to assume Tribal interests would ensure grasshopper treatments would not interfere with events or occur in areas of cultural significance.

### ***(6) Special Considerations for Certain Populations***

Grasshopper suppression programs are likely to occur in the same rural rangeland areas that are largely uninhabited. No matter who conducts the treatments, disproportionately high and adverse human health or environmental impacts on Tribes, and historical and culturally sensitive sites in a program area are unlikely.

Likewise, potential grasshopper control programs would be conducted in rural rangeland areas, where agriculture is a primary industry. These areas consist of widely scattered, single, rural dwellings in ranching communities with low population density. The other agencies and land owners might notify residents within treatment areas to reduce the potential for incidental exposure to residents including children. None the less, treatments would occur 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 APHIS grasshopper 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. Also, program insecticides are not applied while school buses are operating in the treatment area (USDA APHIS, 2016). There is a reasonable expectation that treatments conducted by third parties would also avoid spraying chemicals where children are present or congregate.

### **b) No Grasshopper Population Control**

Conversely, in the absence of an APHIS funded grasshopper suppression program the most likely environmental effects would result from other agencies and land managers not controlling outbreaks. As noted, grasshoppers consuming vast amounts of vegetation in rangelands and surrounding areas. Grasshoppers are generalist feeders, eating grasses and forbs first and often moving to cultivated crops. High grasshopper density of one or several species and the resulting defoliation may reach an economic threshold where the damage caused by grasshoppers exceeds the cost of controlling the grasshoppers. Researchers determined that during typical grasshopper infestation years, approximately 20% of forage on western rangeland is removed, valued at a estimated cost of \$1.2 billion per year (Hewitt & Onsager, 1983; dollar amount adjusted). 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 grasshopper outbreaks in rangeland.

#### **(1) Human Health**

The risk of accidental exposure to insecticides would be reduced if no grasshopper control programs are implemented by APHIS or third parties. Grasshopper outbreaks could cause other health hazards including increased dust storms and road hazards.

#### **(2) Nontarget Species**

Vegetation damage during serious grasshopper outbreaks may be so severe that all grasses and forbs are destroyed causing impaired plant growth for several years. Rare plants may be consumed during critical times of their development such as during seed production, and loss of important plant species, or seed production may lead to reduced biological diversity of the rangeland habitats, potentially creating opportunities for the expansion of invasive and exotic weeds (Lockwood and Latchininsky, 2000). Rangeland herbivorous wildlife would have to migrate or suffer food shortages caused by the loss of forage.

#### **(3) Physical Environment Components**

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). A reduction in vegetation will make steep rangeland topography more susceptible to erosion which would cause additional sediment loading in streams, rivers, and other water bodies. This would result in a decrease in water quality. Likewise the denuded rangeland caused by poor grasshopper control would have less evapotranspiration, lower humidity, and higher daily temperature ranges. During windstorms the dry soil would be more likely to allow soil particles to become airborne and result in poor air quality and possibly health and other physical hazards to humans.

#### **(4)     *Socioeconomic Issues***

When the density of grasshoppers reaches economic injury 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). 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. Local communities and families with ranching based incomes could see adverse economic impacts. Grasshoppers that infest rangeland could move to surrounding croplands. Crop agriculture farmers could incur economic losses from attempts to chemically control grasshopper populations or due to the loss of their crops. The general public could see an increase in the cost of meat, crops, and other agricultural products.

#### **(5)     *Cultural Resources and Events***

The lack of grasshopper treatments would reduce the possibility of accidental spraying by third parties of cultural resources and during activities observing cultural or historically significant events. Grasshopper outbreak populations could reduce recreational and cultural uses of rangeland. Uncontrolled grasshopper populations would make these effects more severe.

#### **(6)     *Special Considerations for Certain Populations***

The risk of accidental human exposure to insecticides would be reduced if no grasshopper control programs are implemented by APHIS or third parties.

As previously noted, the general public could see an increase in the cost of meat, crops, and other agricultural products. Low-income populations would suffer greater relative economic hardship from this increase in food prices, especially where grocery shopping choices are limited by longer travel between small rural villages. Likewise, the cost of food staples for families with children could increase.

## **2. Alternative 2 -Insecticide Applications at Conventional Rates or Reduced Agent Area Treatments with Adaptive Management Strategy**

Under Alternative 2, APHIS would participate in grasshopper programs with the option of using one of the insecticides carbaryl or diflubenzuron, depending upon the various factors related to the grasshopper outbreak and the site-specific characteristics. The use of an insecticide would typically occur at half the conventional application rates following the RAATs strategy. APHIS would apply a single treatment to affected rangeland areas to

suppress grasshopper outbreak populations by a range of 35 to 98 percent, depending upon the insecticide used.

**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.

**(1) Human Health**

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, 2009a; Beauvais, 2014). USEPA classifies carbaryl as “likely to be carcinogenic to humans” based on vascular tumors in mice (USEPA, 2007, 2015a, 2017).

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). 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 half a pound active ingredient per acre per year (USEPA, 2012a). 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 below the tolerance levels.

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 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 revealing low health risks associated with carbaryl.

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. Program workers are the most likely human population to be exposed. APHIS does not expect adverse health risks to workers based on low potential for exposure to liquid

carbaryl when applied according to label directions and use of personal protective equipment (e.g., long-sleeved shirt and long pants, shoes plus socks, chemical-resistant gloves, and chemical-resistant apron) (USEPA, 2012a) during loading and applications. APHIS quantified the potential health risks associated with accidental worker exposure to 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>).

Adherence to label requirements and additional program measures designed to reduce exposure to workers 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.

## **(2) *Nontarget Species***

The APHIS HHERA 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 (USDA APHIS, 2019a). However, adherence to label requirements and additional program measures designed to prevent carbaryl from reaching sensitive habitats or mitigate exposure of non-target organisms will reduce environmental effects of treatments.

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. However, 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 three to ten days, suggesting mammal exposure would be short-term. Direct risks to mammals from carbaryl bait applications is expected to be minimal based on oral, dermal, and inhalation studies (USDA APHIS, 2019a).

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 levels (Zinkl et al., 1977); however, the doses were twice those proposed for the full coverage application in the grasshopper program.

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 in the 2019 EIS. 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.

While sublethal effects have been noted in fish with depressed AChE, as well as some impacts to amphibians (i.e. days to metamorphosis) and aquatic invertebrates in the field

due to carbaryl, the application rates and measured aquatic residues observed in these studies are well above values that would be expected from current program operations. Indirect risks to amphibian and 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.

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.

Research from Gao et al. found that chronic exposure to Carbaryl led to several negative effects on adult bees including impacts on nesting performance, foraging ability and gut microbial community. The researchers posited the no observed adverse effect concentration (NOAEC) of the chronic toxicity test of carbaryl (5 mg/L) to *A. mellifera* larvae were much higher than the field-realistic levels as well as the residual levels detected in bee products. They designed this study to expand the risk assessment to the chronic effects of carbaryl on the transcriptional and metabolic level of *A. mellifera* larvae at the concentration where no adverse reactions were observed.

Stock solution of carbaryl was prepared by dissolving the powder in acetone and then diluted with normal components of bee diet (50% royal jelly, 2% yeast extract, 9% d-glucose, 9% d-fructose). The final concentration of 2 mg/L carbaryl was applied to the third instar larvae for four days and correspond to the no observed adverse effect concentration (NOAEC) determined in a previous study from the researchers (Yang et.al. 2019). However, they noted the carbaryl concentration on developing larvae was 48 times the maximum residual value in nectar or honey.

Carbaryl exposure at the NOAEC disrupted the transcriptional and metabolic regulatory networks of bees, even though no adverse physiological effects were observed in exposed larvae. Metabolome analysis showed that carbaryl treatment led to reduction of amino acids, accumulation of nucleic acid components, and disturbed flavonoids and fatty acids in exposed larvae which would suggest that chronic exposure to carbaryl might change internal metabolism in bee larvae (Gao et al., 2022).

Research from Novotny et al. found that pesticides that are traditionally considered contact-based and applied when flowers are unopened can reach pollen and nectar and produce measurable risk to bees. The persistence of some agrochemicals in leaves, pollen, and nectar up to a week following application merits consideration when managing pollinator-dependent crops. Novotny et al. analyzed residues of three insecticides (carbaryl, lambda-cyhalothrin, permethrin) and three fungicides (chlorothalonil, quinoxyfen, triflumizole) in pumpkin leaves, pollen, and nectar collected from five farms in the north-central United States, one day before a spray event, and one, three, and seven days after. Bees foraging on pumpkin flowers were collected one day before and one day after spraying and screened for the same pesticides. Chemical concentrations and application rates were decided by the farmer based on what a typical schedule would look like. The pumpkin seeds had a

systemic treatment containing three fungicides and the neonicotinoid insecticide thiamethoxam.

The octanol-water partition coefficient ( $\log K_{ow}$ ) is the relative concentration of a chemical in n-octanol versus water at pH 7, 20°C. Higher values of  $\log K_{ow}$  indicate greater lipophilicity (and a lower affinity for water). Since carbaryl has a  $\log K_{ow}$  value of 2.36 the chemical is less likely to adsorb and accumulate in lipid-rich plant tissues such as cuticular waxes or pollen. A chemical's ionizability is given as  $pK_a$ , the pH at which a chemical is 50% ionized, or in equilibrium between its undissociated and ionized state (calculated as the negative base-10 logarithm of the acid dissociation constant at 25°C). Chemicals with  $pK_a < 7$  are most likely to reach vascular tissue and mobilize systemically throughout the plant. A 'neutral'  $pK_a$  indicates the chemical does not ionize under relevant plant conditions. Carbaryl does not offer systemic insecticidal protection because the chemical has a  $pK_a$  of 10.4. However, carbaryl has a molecular weight of 201.2 g/mol well below 800 g/mol, the molecular weight typical of chemicals that are able to penetrate plant cuticles (University of Hertfordshire Agriculture and Environment Research Unit. Pesticide properties database (PPDB). 2024. [Cited 1 March 2024]. Available from: <http://sitem.herts.ac.uk>).

The researchers found foliar insecticide and fungicide spray residues were detected more frequently and in greater concentrations in pumpkin leaves than in pollen, nectar, or foraging bees and insecticide concentrations in leaves often exceeded levels of concern. However, the risk indices used to examine pollinator exposure against the levels of concern assume that a foraging bee would actually come into contact with all the chemical present on or in the leaf sample.

Carbaryl applied to foliage was present in some plant pollen and nectar samples, and in two or the 69 bee samples (male *X. pruinosa*) collected one day after a spraying event. The researchers noted the bees that tested positive (male squash bees) have life history traits that bring them into prolonged contact with sprayed crop plants. Typically, either the proportion of contaminated samples or the maximum concentration of insecticides in pumpkin tissues decreased over the week following foliar application. For example, one day after application of carbaryl spray 43% of nectar samples tested positive for the insecticide, but carbaryl was not present in nectar samples collected one week later. However, the pretreatment data suggested carbaryl residues can persist longer than a week in leaves and pollen.

Carbaryl has only moderate lipophilicity ( $\log K_{ow} = 2.4$ ), giving it more potential to mobilize vascularly and be incorporated into developing floral tissue. Consistent with this reasoning, the researchers recorded a five-fold increase in carbaryl concentrations in pollen from the first to the third day after treatment. Carbaryl has a low molecular weight and is a very weak acid. Therefore, the chemical can cross membranes and bind with compounds in plant cells with similar pH before it reaches phloem. These properties contribute to its persistence in leaves, instead of translocation to pollen and nectar that bees eat. However, this persistence prolongs pollinator risk of exposure. The high concentrations of carbaryl in leaves during the week after foliar spray led to the highest bee risk quotient values. As previously noted, the assessments may overestimate bee toxicity from leaf contact because

they assume a bee receives the entire dose of chemical present in the leaf sample (Novotny et al., 2024).

Researchers analyzed persistence of pesticides in agroecosystems in the Emilia-Romagna region of northern Italy (Bogo et al. 2024). They investigated pesticide residue in beebread by analyzing 100 samples collected in 25 BeeNet national monitoring project stations in March and June of 2021 and 2022. They looked at the diversity and concentration of the chemicals, their correlation with land use, and the risk they posed to the bees. They calculated a toxicity-weighted concentration (TWC) of chemicals by computing the ratio between the measured concentration in beebread and the oral acute toxicity (LD<sub>50</sub>) of that chemical for bees. For risk evaluation a risk threshold was assigned by dividing the TWC by an order of magnitude to account for chemical degradation, harmful synergistic interaction with other chemicals and chronic exposure causing sublethal effects. The risk threshold was exceeded in four beebread samples out of 100; one for carbaryl, fipronil, imidacloprid and thiamethoxam (Bogo et al. 2024).

Research from Nogrado et al. investigated the effect of carbaryl pesticides on gut microbiota of honeybees, which had come in contact with rapeseed plants (*Brassica napus*) sprayed with carbaryl wettable powder. Honeybee colonies were placed in tunnels covering an area of 70 meters squared and containing *Brassica napus*. Negative controls were sprayed with tap water (400 L/ha), while the experiments were sprayed with carbaryl (250 g a.i./ha in 400 L tap water/ha) during active flight of bees. Bees were collected from the negative control and the carbaryl-treated groups, after 2 h of exposure. The unexposed bees harbored *Alphaproteobacteria*, which were absent in the exposed bees. Microorganisms found in honeybee guts such as *Snodgrassella alvi* and *L. kullabergensis*, however, were observed only in the exposed bees, but not in the unexposed bees. The difference between the two groups was distinctly recognized when copy numbers of 16S rRNA genes were compared by quantitative PCR. The researchers noted they could not conclude decisively that the differences in the composition of the gut microbial communities from the two groups can be attributed directly to the pesticide exposure. However other researchers (Raymann et al.) have suggested that one difference between a healthy colony and a colony suffering from colony collapse disorder can be a decrease in *Alphaproteobacteria* in gut bacterial communities. Lastly, there were other bacteria that are not commonly found in the gut microbiota of honeybees could have been acquired from the environment and could be considered as opportunistic pathogens. These uncategorized bacteria were observed in more abundance in the exposed group as compared to the unexposed group. *Klebsiella* was only observed in the unexposed group, while *Cronobacter*, *Edwardsiella*, *Providencia*, *Serratia*, *Erwinia*, and *Pantoea* were observed in the exposed group. The researchers suggested the uncategorized bacteria could probably be indicative of disruption of balance of gut microbiome or disease as mentioned in previous studies in relation to dysbiosis in the presence of a potential cause like chemicals.

The researchers noted the analysis could measure endpoints of sublethal effects, but there is considerable uncertainty in how to relate to adverse effects. Furthermore, there is insufficient data to establish plausible adverse outcome pathways with consistent and reproducible linkages between molecular initiating events and key events across multiple

levels of biological organization to an adverse effect at the whole organism or colony or population level (Nogrado et.al.2019).

Laboratory studies have indicated that bees can be harmed by acute exposures to carbaryl, but the studies were at rates above those proposed in the program. The chronic exposures and effects modelled in the studies described above are unlikely to result from one-time applications conducted by the program. Potential negative effects of grasshopper program insecticides on bee populations may also be mitigated by the more common use of carbaryl baits than the ULV spray formulation. Studies with carbaryl bran bait have found no sublethal effects on adults or larvae bees (Peach et al., 1994, 1995). The reduced rates of carbaryl used in the program and the implementation of application buffers should significantly reduce exposure of pollinators to carbaryl treatments for grasshopper suppression. In areas of direct application where impacts may occur, alternating swaths and reduced rates (i.e., RAATs) would reduce risk. The effects on pollinators resulting from control of rangeland grasshopper populations with carbaryl based insecticides are not expected to cause significant impacts to the human environment.

### **(3) Physical Environment Components**

Temperature, pH, light, oxygen, and the presence of microorganisms and organic material are factors that contribute to how quickly carbaryl will degrade in water. Hydrolysis, the breaking of a chemical bond with water, is the primary degradation pathway for carbaryl at pH 7 and above. 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 natural waters varied between 0.3 to 4.7 days (Stanley and Trial, 1980; Bonderenko et al., 2004).

Degradation in the latter study was temperature dependent with shorter half-lives at higher temperatures. Aerobic aquatic metabolism of carbaryl reported half-life ranged 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, 2003). Carbaryl's degradation in aerobic soil varies from rapid to slow with half-lives ranging from 4 to 253 days (USEPA, 2017). Half-lives decrease with increasing pH from acidic to alkaline conditions. Under anaerobic soil conditions, carbaryl has a half-life of 72 days. 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).

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, or to areas where surface water is present (USEPA, 2012a). 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 aquatic exposure and risk.

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, however these minute amounts of carbaryl are not expected to reduce air quality. Carbaryl hydrolysis occurs quickly in natural waters with pH values of 7 or above, and the presence of microorganisms

and organic material also contribute to the rapid degradation of the chemical. Adverse effects resulting from carbaryl contamination of water resources would harm aquatic organisms (described above) and would be temporary or de minimis.

#### **(4) Socioeconomic Issues**

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 analysis of making a treatment. Because of the cost sharing private landowners and land managers typically would only use carbaryl to suppress rangeland grasshoppers and preserve forage for livestock. 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 57 to 66% with carbaryl.

Another potential economic benefit of chemical treatment of grasshoppers is to crop growers near rangelands. Carbaryl bait treatments are sometimes used to reduce the potential for rangeland grasshoppers to move to surrounding croplands. This would result in socioeconomic benefits because losses, and therefore costs, of meat, crops, and their byproducts should be reduced. Additionally, the suppressed grasshopper populations in rangeland surrounding croplands could mean less of a need for costly chemical treatments by crop farmers at these sites.

There is the potential for organic farms adjacent to carbaryl spray applications in rangeland to control grasshopper outbreak populations. However, mitigations such as buffers are meant to protect adjacent environments from runoff and insecticide drift. These protective measures are expected to protect nearby organic farms, as well as other areas of concern, from the risk of inadvertent exposure to rangeland insecticide treatments. It is also likely the organic farms would also benefit economically from reductions in crop damage caused by grasshopper populations migrating from nearby rangeland.

The suppression of grasshopper populations with carbaryl should benefit 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 carbaryl insecticide applications. However, the preservation of vegetation is expected to benefit recreational activities in the long-term by preserving their aesthetic value. This in turn will also increase the economic value of the rangeland by preserving and improving recreational opportunities.

#### **(5) Cultural Resources and Events**

There is the potential for impacts to cultural and historical resources if the proposed carbaryl 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 or land management agency, the State Historic Preservation Office, any affected National Trail's administrative office, or other appropriate agencies. Likewise,

APHIS would coordinate the timing of treatments with Tribes or other cooperators to ensure carbaryl treatments would not occur during scheduled cultural events or ceremonies.

#### ***(6) Special Considerations for Certain Populations***

APHIS uses carbaryl insecticide treatments to suppress grasshopper populations in rural rangeland areas that are largely uninhabited. Disproportionately high and adverse human health or environmental impacts on Tribes, and historical and culturally sensitive sites in a program area are unlikely.

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. Also, program insecticides are not applied while school buses are operating in the treatment area (USDA APHIS, 2016).

APHIS' HHERA for carbaryl evaluated the potential exposure to each insecticide used in the program and risks associated with these insecticides to residents, including children. The HHERA suggest that no disproportionate risks to children, as part of the general public, are anticipated (USDA APHIS, 2019a).

#### **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.

#### ***(1) Human Health***

Adverse human health effects from ground or aerial ULV applications of diflubenzuron to control grasshoppers are not expected based on the chemical's low acute toxicity and low potential for human exposure. Diflubenzuron has low acute dermal toxicity in rabbits and very low acute oral and inhalation toxicities in rats (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. 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 personal protective equipment (PPE) during applications (e.g., long sleeve shirt and pants, chemical-resistant gloves). 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 (USDA APHIS, 2019b).

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). 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.

Adverse health risk to the general public in treatment areas is not expected due to the low potential for exposure resulting from low population density in the treatment areas, adherence to label requirements, 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. The quantitative risk evaluation results indicate no concerns for adverse health risk for humans (USDA APHIS, 2019b).

## **(2) *Nontarget Species***

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 methemoglobinemia. Minimal direct risk to amphibians and reptiles is expected, although there is some uncertainty due to lack of information (USDA APHIS, 2019c; USEPA, 2018).

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 three to 16 times greater than the highest application rate proposed in the program. Potential indirect impacts from application of diflubenzuron on small mammals includes loss of habitat or food items. Mice on treated plots consumed fewer lepidopteran (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.

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. At the proposed application rates, grasshoppers have the highest risk of being impacted while other taxa have a greatly reduced risk because the lack of effects seen in multiple field studies on other taxa of invertebrates at use rates much higher than those proposed for the program. 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).

Indirect risk to fish species can be defined as a loss of habitat or prey base that provides food and shelter for fish populations, however these impacts are not expected based on the available fish and invertebrate toxicity data (USDA APHIS, 2019c). 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 FS, 2004).

Diflubenzuron applications have the potential to affect chitin production in various other beneficial terrestrial 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. Immature grasshoppers, beetle larvae, lepidopteran larvae, and chewing herbivorous insects appear to be more susceptible to diflubenzuron than other invertebrates. Within this group, however, grasshoppers appear to be more sensitive to the proposed use rates for the program. Honeybees, 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, 2019c). 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. Grasshopper integrated pest management (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 seven 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).

Due to its mode of action, diflubenzuron has greater activity on immature stages of terrestrial invertebrates. Based on standardized laboratory testing diflubenzuron is considered practically non-toxic to adult honeybees. The contact LD<sub>50</sub> value for the honeybee, *Apis mellifera*, is reported at greater than 114.8 µg a.i./bee while the oral LD<sub>50</sub> value was reported at greater than 30 µg a.i./bee. USEPA (2018) reports diflubenzuron toxicity values to adult honeybees are typically greater than the highest test concentration using the end-use product or technical active ingredient. The lack of toxicity to honeybees, as well as other bees, in laboratory studies has been confirmed in additional studies (Nation et al., 1986; Chadel and Gupta, 1992; Mommaerts et al., 2006). Mommaerts et al. (2006) and Thompson et al. (2005) documented sublethal effects on reproduction-related endpoints

for the bumble bee, *Bombus terrestris* and *A. mellifera*, respectively, testing a formulation of diflubenzuron. However, these effects were observed at much higher use rates relative to those used in the program.

For example, in the Mommaerts et al. study researchers exposed bees via a contact application of 288 mg/L aqueous concentration which was topically applied to the dorsal thorax of each worker with a micropipette. Bumblebees also ingested orally sugar/water treated with the same concentration of diflubenzuron solution over a period of 11 weeks. Pollen was sprayed with the same concentration of diflubenzuron until saturation and then supplied to the nests. The bumble bees were not restricted in how much of these contaminated solutions they could consume. The researchers estimated mean LC50 concentrations based on the chronic exposure routes described above. These were 25 mg a.i/L dermal contact, 0.32 mg a.i/L ingested sugar-water, and 0.95 mg a.i/L pollen. The researchers noted, “In practice, bumblebees will rarely be exposed to such high concentrations,” and elaborated, “it is necessary that the laboratory-based results are validated with risk assessments for these insecticides in field related conditions.”

APHIS believes conversion and comparison of program applied foliar spray rates to the concentrations of the solutions applied in this study would rely on unrealistic exposure scenarios. An exposure scenario where pollinators are exposed continuously for 11-weeks is not expected to occur in the APHIS grasshopper and Mormon cricket suppression program. In field applications diflubenzuron levels would decline over the 11-week exposure period due to degradation, flowering plants that have diflubenzuron residues would no longer be available for foraging by pollinators as flowers naturally die and do not provide pollen and nectar, and other plants would bloom after application without residues of diflubenzuron.

Diflubenzuron has been associated with several potentially harmful effects on bees, even when mortality was not recorded. Research from Camp et al. used Eastern bumble bee (*Bombus impatiens*) as surrogates to measure the effect that diflubenzuron has on bee behavior. Diflubenzuron (0.1, 1, 10, 100, 1,000 µg/liter) was formulated as an emulsion of the sugar syrup with 0.5% (v/v) Honey-B-Healthy and 1% (v/v) acetone and was delivered in syrup feeders. Drone production was reduced in a concentration-dependent manner and the 42-d IC<sub>50</sub> (half-maximal inhibitory concentration) was calculated by Camp et al. to be 28.61 µg/liter diflubenzuron. They found that diflubenzuron delivered via dietary exposure of sucrose was associated with decreased pollen consumption and decreased drone production in bumble bee without there being a significant increase in adult mortalities (Camp et al., 2020).

However, the tested solutions of diflubenzuron in the supplied syrup and pollen are greater than the range of the pesticide applied during grasshopper suppression treatments. Diflubenzuron is applied once per year to foliar vegetation and only a minuscule proportion would be to flowers with nectar and pollen. In this experiment the bumble bees were fed syrup and pollen with fresh doses of diflubenzuron three times per week. The same difficulty of applying this study’s findings to real field exposures, as is also the case with Mommaerts et.al., 2006, is described above.

Research from Krueger et al. showed that while diflubenzuron exposure didn't impact bumble bee worker survival, the exposure did result in a significant decrease in drone emergence that is indicative of a greater sensitivity to diflubenzuron in the immature life stage. Microcolonies exposed to 10 mg diflubenzuron/kg pollen (i.e. the pollen was contaminated with 10 parts per million of diflubenzuron) produced fewer adult drones despite no effects on worker survival (Krueger et al., 2021).

A researcher found that exposure to diflubenzuron in a 10 ppm sucrose solution resulted had significant effect on the number of larvae successfully eclosing from eggs three days after collection. The researcher posited that bee embryos with poorly formed cuticle could initiate egg eclosion and perhaps complete it, though the survivorship of the resultant larvae would likely be compromised. The results she reported for diflubenzuron suggest that the larval cuticle was not developed, resulting in mortality before or during the hatching process, and that many of the larvae observed to have hatched may not have survived to the later instar stages. Although the doses examined in this work may be high relative to what has been found inside of honeybee colonies, the exposure did not have an observable effect on egg production. However, successful hatching rates were significantly decreased in response to diflubenzuron, a chitin synthesis inhibitor (Fine 2020).

Further investigations examined two-generational effects to diflubenzuron administered at 1 ppm through the workers' diet, thus exposing queens indirectly in a manner similar to what might occur in the field (Fine et al., 2023). The researchers tracked queen performance and worker responses to queens, then the performance of the exposed queens' offspring was assessed to identify patterns that may contribute to the long-term health and stability of a social insect colony.

None of the treatments had a significant effect on the total number of eggs laid. Treated worker diets had no effect on retinue response. No differences were detected between treatment groups in the consumption of pollen supplement. Treatment had no effect on worker survival and over the two-week monitoring period, mortality rates remained below 3.2% on average across all groups. No difference was detected between treatment groups in queen weight change. Major royal jelly protein-1, MRJP-3, vitellogenin, and vitellogenin precursor proteins were among those quantified, but their abundances were not different with respect to the control queens. The researchers investigated global patterns of differential protein abundance between exposure groups and found no proteins in the diflubenzuron group were significantly altered.

Receiving care from maternally-exposed workers did not have an effect on the laying rates of new queens or their total eggs produced. Receiving care from maternally-exposed workers did not affect the egg hatching rate of eggs laid by new queens or rate of adult eclosions relative to controls. Treatment also had no effect on worker pollen consumption, queen weight change, or weight at adult eclosion. However, treatment had a significant effect on the timing of adult eclosion. Maternal exposure to diflubenzuron and methoxyfenozide resulted in significantly longer average time to adult eclosion relative to maternal exposure to pyriproxyfen or the control group. Maternal pesticide treatment had

no effect on worker survival and over the two week monitoring period, mortality rates remained below 1.7% on average across all groups, and no queen death was observed.

Researchers examined synergistic toxicity of common insecticides and fungicides in California almond orchards. Synergistic toxicity is the toxicity of a chemical combination that is greater than that predicted from studies of isolated chemical constituents. Young worker larvae were fed diets contaminated with 2.28  $\mu\text{g}$  diflubenzuron per larva and a fungicidal dose to achieve comparable concentration ratios simulating a tank-mix at the maximum label rate. Diflubenzuron cause significantly reduced adult emergence as measured by larval mortality, but no synergistic effect was observed when combined with fungicides (Wade et al., 2019).

During June 2024 the USDA Agricultural Research Service (ARS) collected 58 plant tissue samples from flowers within a grasshopper treatment area in Prairie County, Montana. The samples were sent to the USDA Agricultural Marketing Service – National Science Laboratory for analysis to determine the concentration of diflubenzuron residue both 24 hours and 14 days after the application. Nine pretreatment flower tissue samples were accidentally collected before the insecticide application because of miscommunication between the PPQ program manager, the ARS field technician and the pilot. The program uses the RAATs method where spray and no-spray swaths are alternated. However, deposition of insecticide within the spray and no-spray swaths is variable because of changes in wind direction and speed, as well as the application height which is dictated by topography and other hazards. Of the 25 flower samples collected 24 hours after the treatment, 14 did not have detectable amounts of diflubenzuron, as was also the case with the nine pretreatment samples. The sample location coordinates, and applicator flight path software indicated only ten of these samples were collected in between spray swaths (i.e. within skip swaths). Laboratory analysis showed six samples collected within skip swaths, 24 hours after the aerial spray treatment had diflubenzuron residues. Of the 24 samples collected 14 days after the treatment, 16 did not have detectable amounts of diflubenzuron. Five of the eight samples that had diflubenzuron residues 14 days after treatment were collected in skip swaths.

Nine of the 11 contaminated flower samples collected 24 hours after the treatment had measurable amounts of diflubenzuron that diminished in samples collected at the same location 14 days later. Laboratory analysis showed flower samples collected at five sample locations did not have detectable concentrations one day after the treatment, but did have diflubenzuron residues when samples were collected at the same or nearby locations 14 days later. Diflubenzuron residues on five flower samples collected immediately after treatment either did not attenuate significantly or had greater amounts of the chemical when more samples were collected at the same or adjacent locations 14 days later.

To assess risk to bees from contact with the rangeland flowers and leaves while collecting pollen and nectar after foliar diflubenzuron treatments we calculated the hazard quotient (HQ). The HQ was calculated as the average concentration of diflubenzuron residues detected on plant tissue for both the samples collected 24 hours and 14 days after the treatment divided by acute contact LD<sub>50</sub> (Stoner and Eitzer 2013). Non-detection results were assigned a value of 0.099 parts per million (ppm), just below the limit of detection

value of 0.100 ppm. Honeybee LD<sub>50</sub> was used as LD<sub>50</sub> was not consistently available for bumble and solitary bees.

$$\text{HQ (24 hours)} = 360 \text{ ppb (0.36 ppm)} \div 114.8 \text{ } \mu\text{g diflubenzuron per bee} = 3.136$$

$$\text{HQ (14 days)} = 159 \text{ ppb (0.159 ppm)} \div 114.8 \text{ } \mu\text{g diflubenzuron per bee} = 1.385$$

This analysis can be interpreted there is not a significant risk to bees using a common level of concern (LOC) of HQ > 50 (Thompson and Thorbahn 2009; Thompson 2021).

Extrapolation to other pollinators by multiplying the HQ by an order of magnitude also did not indicate significant acute health risk from contact with the flowers with diflubenzuron residues.

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 using reduced rates and creating untreated swaths within the spray block that will further reduce the potential risk to pollinators.

APHIS reduces the risk to native bees and pollinators through monitoring grasshopper and Mormon cricket populations and making pesticide applications in a manner that reduces the risk to this group of nontarget invertebrates. Monitoring grasshopper and Mormon cricket populations allows APHIS to determine if populations require treatment and to make treatments in a timely manner reducing pesticide use and emphasizing the use of program insecticides that are not broad spectrum. The treatment history of program since the introduction of diflubenzuron demonstrates it is the preferred insecticide. Over 90% of the acreage treated by the program has been with diflubenzuron. The effects on pollinators resulting from control of rangeland grasshopper populations with diflubenzuron are not expected to cause significant impacts to the human environment.

### **(3) Physical Environment Components**

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). The vapor pressure of diflubenzuron is relatively low, as is the Henry's Law Constant value, suggesting the chemical will not volatilize readily into the atmosphere from soil, plants or water.

Therefore, exposure from volatilization is expected to be minimal. 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). Mobility and leachability of diflubenzuron in soils is low, and residues are usually not detectable after seven days (Eisler, 2000). Aerobic aquatic half-life data in water and sediment was reported as 26.0 days (USEPA, 1997). 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). Field dissipation studies in California citrus and Oregon apple orchards reported half-life values of 68.2 to 78 days (USEPA, 2018). Diflubenzuron persistence varies depending on site conditions and rangeland persistence is unfortunately not available. Diflubenzuron degradation is microbially mediated with soil aerobic half-lives much less

than dissipation half-lives. 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, 2019c).

#### **(4) Socioeconomic Issues**

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 estimate of making a treatment. Because of the cost sharing private landowners and land managers typically would only use diflubenzuron to suppress rangeland grasshoppers and preserve forage for livestock. Insecticides applied using the RAATs strategy is expected to provide further economic advantages due to effective treatment at reduced costs. The RAATs strategy reduces treatment costs to half of the costs for conventional treatments for rangeland grasshopper infestations (Foster et al., 2000, Lockwood and Schell, 1997).

Another potential economic benefit of chemical treatment of grasshoppers is to crop growers near rangelands. This would result in socioeconomic benefits because losses, and therefore costs, of meat, crops, and their byproducts should be reduced. Additionally, the suppressed grasshopper populations in rangeland surrounding croplands could mean less of a need for costly chemical treatments by crop farmers at these sites.

There is the potential for organic farms adjacent to diflubenzuron treatments in rangeland to control grasshopper outbreak populations. However, mitigations such as buffers are meant to protect adjacent environments from runoff and insecticide drift. These protective measures are expected to protect nearby organic farms, as well as other areas of concern, from the risk of inadvertent exposure to rangeland insecticide treatments. It is also likely the organic farms would also benefit economically from reductions in crop damage caused by grasshopper populations migrating from nearby rangeland.

The suppression of grasshopper populations with diflubenzuron should benefit 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 diflubenzuron insecticide applications. However, the preservation of vegetation is expected to benefit recreational activities in the long-term by preserving their aesthetic value. This in turn will also increase the economic value of the rangeland by preserving and improving recreational opportunities.

#### **(5) Cultural Resources and Events**

There is the potential for impacts to cultural and historical resources if the proposed diflubenzuron 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 or land management agency, the State Historic Preservation Office, any affected National Trail's administrative office, or other appropriate agencies. Likewise, APHIS would coordinate the timing of treatments with Tribes or other cooperators to ensure insecticide applications would not occur during scheduled cultural events or ceremonies.

#### **(6) Special Considerations for Certain Populations**

APHIS uses diflubenzuron insecticide treatments to suppress grasshopper populations in rural rangeland areas that are largely uninhabited. Disproportionately high and adverse human health or environmental impacts on Tribes, and historical and culturally sensitive sites in a program area are unlikely.

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 school properties. Also, program insecticides are not applied while school buses are operating in the treatment area (USDA APHIS, 2016).

APHIS' HHERA for diflubenzuron evaluated the potential exposure to each insecticide used in the program and risks associated with these insecticides to residents, including children. The HHERA suggest that no disproportionate risks to children, as part of the general public, are anticipated (USDA APHIS, 2019c).

## **IV. Conclusions**

This EA examines alternatives available to APHIS when requested to suppress economically damaging outbreaks of grasshoppers. The preferred alternative includes insecticide treatments which are chosen based on the site conditions. APHIS decides whether insecticide treatments are warranted based on the IPM principles including an assessment of the economic injury level represented by the grasshopper populations. This EA discusses and examines the tools and strategies employed by APHIS and their potential effects on the human environment. This EA does not decide which alternative will be selected, however, all reasonable options available to the agency for dealing with grasshopper infestations have been adequately considered, including consideration of direct, indirect and cumulative environmental effects. Decisions about whether, how, and when to employ the tools and strategies discussed in the EA will be made as the need to suppress grasshopper populations at specific sites arises.

In June 2002, APHIS completed an EIS describing the agency's most effective methods of reducing the damage caused by grasshopper populations to rangeland in the western United States. During November 2019, APHIS published HHERA for the use of carbaryl, chlordantraniliprole, diflubenzuron and malathion by the program. APHIS also published an updated EIS to consolidate and incorporate the available data and analyze the environmental risk of new program tools. The risk analysis in the 2019 EIS is incorporated by reference (USDA APHIS, 2019).

This EA examined a No Action alternative, where APHIS would not conduct a program to suppress grasshoppers other than provide technical assistance and surveys to assist in the

implementation of IPM strategies by land managers. Without an APHIS administered program Federal land management agencies, State agriculture departments, local governments, private groups or individuals, may not effectively combat outbreaks in a coordinated effort. Without the coordination that APHIS provides during grasshopper outbreaks, the land managers and owners could use insecticides that APHIS considers too environmentally harsh. Multiple treatments and excessive amount of insecticide could be applied in efforts to suppress or even locally eradicate grasshopper populations. Conversely, in the absence of an APHIS funded grasshopper suppression program the most likely environmental effects would result from other agencies and land managers not controlling outbreaks. As noted, grasshoppers consuming vast amounts of vegetation in rangelands and surrounding areas. Grasshoppers are generalist feeders, eating grasses and forbs first and often moving to cultivated crops.

Under the Preferred Alternative APHIS would participate in grasshopper programs with the option of using one of the insecticides carbaryl or diflubenzuron depending upon the various factors related to the grasshopper outbreak and the site-specific characteristics. The use of an insecticide would typically occur at half the conventional application rates following the RAATs strategy. APHIS would apply a single treatment per year to affected rangeland areas to suppress grasshopper outbreak populations.

Each alternative described in this EA potentially has adverse environmental effects. The general environmental impacts of each alternative are discussed in detail in the 2019 programmatic EIS published by APHIS. The specific impacts of the alternatives are highly dependent upon the particular action and location of the grasshopper infestation. The principal concerns associated with the alternatives are: (1) the potential effects of insecticides on human health (including subpopulations that might be at increased risk); and (2) impacts of insecticides on nontarget organisms (including threatened and endangered species).

## V. Literature Cited

Barbee, G.C., McClain, W.R., Lanka, S.K. and M.J. Stout. 2010. Acute toxicity of chlorantraniliprole to non-target crayfish (*Procambarus clarkii*) associated with rice–crayfish cropping systems. Pest Manag. Sci. 66: 996–1001.

Beauvais, S. 2014. Human exposure assessment document for carbaryl. Page 136. California Environmental Protection Agency, Department of Pesticide Regulation.

Belovsky, G. E., A. Joern, and J. Lockwood. 1996. VII.16 Grasshoppers—Plus and Minus: The Grasshopper Problem on a Regional Basis and a Look at Beneficial Effects of Grasshoppers. Pages 1-5 in G. L. Cunningham and M. W. Sampson, editors. Grasshopper Integrated Pest Management User Handbook, Technical Bulletin No. 1809. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Washington, DC.

Belovsky, G. E. 2000. Part 1. Grasshoppers as integral elements of grasslands. 1. Do grasshoppers diminish grassland productivity? A new perspective for control based on conservation. Pages 7-29 in J. A. Lockwood et al, editor. Grasshoppers and Grassland Health. Kluwer Academic Publishers, Netherlands.

Black SH, Shepherd M, Vaughan M. 2011. Rangeland management for pollinators. *Rangelands* 33(3):9–13. <https://doi.org/10.2111/1551-501x-33.3.9>

Bogo G, Caringi V, Albertazzi S, Capano V, Colombo R, Dettori A, Guerra I, Lora G, Bortolotti L, Medrzycki P. 2024. Residues of agrochemicals in beebread as an indicator of landscape management. *Sci. Total Env.* 945 (2024). <https://doi.org/10.1016/j.scitotenv.2024.174075>

Bonderenko, S., J. Gan, D. L. Haver, and J. N. Kabashima. 2004. Persistence of selected organophosphate and carbamate insecticides in waters from coastal watershed. *Env. Toxicol. Chem.* 23:2649-2654.

Bradshaw, J. D., K. H. Jenkins, and S. D. Whipple. 2018. Impact of grasshopper control on forage quality and availability in western Nebraska. *Rangelands* 40:71-76.

Branson, D., A. Joern, and G. Sword. 2006. Sustainable management of insect herbivores in grassland ecosystems: new perspectives in grasshopper control. *BioScience* 56:743-755.

Broyles, G. 2013. Wildland firefighter smoke exposure. Page 26. U.S. Department of Agriculture, Forest Service.

Brugger, K.E., Cole, P.G., Newman, I.C., Parker, P., Scholz, B., Suvagia, P., Walker, G. and T.G. Hammond. 2010. Selectivity of chlorantraniliprole to parasitoid wasps. *Pest Manag. Sci.* 66: 1075–1081.

Buckner, C. H., P. D. Kingsbury, B. B. McLeod, K. L. Mortensen, and D. G. H. Ray. 1973. The effects of pesticides on small forest vertebrates of the spruce woods provincial forest, Manitoba. *The Manitoba Entomologist* 7:37-45.

Burling, I., R. Yokelson, D. Griffith, T. Johnson, P. Veres, J. Roberts, C. Warneke, S. Urbanski, J. Reardon, D. Weise, W. Hao, and J. de Gouw. 2010. Laboratory measures of trace gas emissions from biomass burning of fuel types from the southeastern and southwestern United States. *Atmospheric Chemistry and Physics* 10:11115-111130.

Camp AA, Batres A, Williams WC, Lehmann DM. 2020. Impact of Diflubenzuron on *Bombus Impatiens* (Hymenoptera: Apidae) Microcolony Development. *Environmental Entomology* Vol. 49 (1): 203–10. <https://doi.org/10.1093/ee/nvz150>.

Caro, J. H., H. P. Freeman, and B. C. Turner. 1974. Persistence in soil and losses in runoff of soil-incorporated carbaryl in a small watershed. *J. Agricul. Food Chem.* 22:860-863.

Catangui, M.A., Fuller, B.W., and Walz, A.W., 1996. Impact of Dimilin® on nontarget arthropods and its efficacy against rangeland grasshoppers. In U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 1996. *Grasshopper Integrated Pest Management User Handbook*, Tech. Bul. No. 1809. Sec. VII.3. Washington, DC.

Chandel, R.S., and P.R Gupta. 1992. Toxicity of diflubenzuron and penfluron to immature stages of *Apis cerana indica* and *Apis mellifera*. *Apidologie* 23:465–473.

Cordova, D. E. E.A. Benner, M.D. Sacher, J.J. Rauh, J.S. Sopa, G.P. Lahm, T.P. Selby, T.M. Stevenson, L. Flexner, S. Gutteridge, D.F. Rhoades, L. Wu, R.M. Smith, Y. Tao (2006). Anthranilic diamides: a new class of insecticides with a novel mode of action, ryanodine receptor activation. In *Pesticide Biochemistry and Physiology* (pp. 196-214).

Cooper, R. J., K. M. Dodge, P. J. Marinat, S. B. Donahoe, and R. C. Whitmore. 1990. Effect of diflubenzuron application on eastern deciduous forest birds. *J. Wildl. Mgmt.* 54:486-493.

Council on Environmental Quality. 2005. Guidance on the consideration of the consideration of past actions in cumulative effects analysis. Council on Environmental Quality. Washington, D.C., USA.

Deakle, J. P. and J. R. Bradley, Jr. 1982. Effects of early season applications of diflubenzuron and azinphosmethyl on populations levels of certain arthropods in cotton fields. *J. Georgia Entomol. Soc.* 17:189-200.

Deneke, D. and J. Keyser. 2011. Integrated Pest Management Strategies for Grasshopper Management in South Dakota. South Dakota State University Extension.

Dinkins, M. F., A. L. Zimmermann, J. A. Dechant, B. D. Parkins, D. H. Johnson, L. D. Igl, C. M. Goldade, and B. R. Euliss. 2002. Effects of Management Practices on Grassland Birds: Horned Lark Northern Prairie Wildlife Research Center. Page 34. Northern Prairie Wildlife Research Center, Jamestown, ND.

Dinter, A., Brugger, K.E., Frost, N.M. and M.D. Woodward. 2009. Chlorantraniliprole (Rynaxypyr): A novel DuPont™ insecticide with low toxicity and low risk for honey bees (*Apis mellifera*) and bumble bees (*Bombus terrestris*) providing excellent tools for uses in integrated pest management. Hazards of pesticides to bees – 10th International Symposium of the ICP-Bee Protection Group. Pp. 84-96.

Dinter A, Klein O, Franke L. 2021. Lack of Effects On Bumblebee (*Bombus Terrestris*) Colony. Preprint manuscript. DOI:10.21203/rs.3.rs-572507/v1

Dobroski, C. J., E. J. O'Neill, J. M. Donohue, and W. H. Curley. 1985. Carbaryl: a profile of its behaviors in the environment. Roy F. Weston, Inc. and V.J. Ciccone and Assoc., Inc., West Chester, PA; Woodbridge, VA.

Dolan AC, Delphia CM, O'Neill KM, Ivie MA. 2017. Bumble Bees (Hymenoptera: Apidae) of Montana. *Annals of the Entomological Society of America*, Volume 110, Issue 2, March 2017, Pages 129–144. <https://doi.org/10.1093/aesa/saw064>

Dupont. 2012. Material Safety Data Sheet - Prevathon®.

Eisler, R. 1992. Diflubenzuron Hazards to Fish, Wildlife, and Invertebrate: A Synoptic Review. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

Eisler, R., 2000. Handbook of chemical risk assessment: health hazards to humans, plants, and animals. Lewis Publishers, New York.

El-Refai, A. and T. L. Hopkins. 1972. Malathion adsorption, translocation, and conversion to malaoxon in bean plants. *J. Assoc. Official Analytical Chemists* 55:526-531.

Fine JD. 2020. Evaluation and comparison of the effects of three insect growth regulators on honey bee queen oviposition and egg eclosion. *Ecotox Environ Saf.* 2020; 205: 111142. <https://doi.org/10.1016/j.ecotox.2020.111142>.

Fine JD, Foster LJ, McAfee A. 2023. Indirect exposure to insect growth disruptors affects honey bee (*Apis mellifera*) reproductive behaviors and ovarian protein expression. *PLoS ONE* 18(10): e0292176. <https://doi.org/10.1371/journal.pone.0292176>

Fischer, S. A. and L. W. Hall, Jr. 1992. Environmental concentrations and aquatic toxicity data on diflubenzuron (Dimilin). *Critical Rev. in Toxicol.* 22:45-79.

Follett, R. F. and D. A. Reed. 2010. Soil carbon sequestration in grazing lands: societal benefits and policy implications. *Rangeland Ecology & Management* 63:4-15.

Forister ML, Halsch CA, Nice CC, Fordyce JA, Dilts TE, Oliver JC, Prudic KL, Shapiro AM, Wilson JK, Glassberg J. 2021. Fewer butterflies seen by community scientists across the warming and drying landscapes of the American West. *Science* Vol. 371, 1042–1045. <https://www.science.org/doi/10.1126/science.abe5585>

Foster, R. N., K. C. Reuter, K. Fridley, D. Kurtenback, R. Flakus, R. Bohls, B. Radsick, J. B. Helbig, A. Wagner, and L. Jeck. 2000. Field and Economic Evaluation of

Operational Scale Reduced Agent and Reduced Area Treatments (RAATs) for Management of Grasshoppers in South Dakota Rangeland. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Phoenix, AZ.

Gao J, Yang Y, Ma S, Liu F, Wang Q, Wang X, Wu Y, Zhang L, Liu Y, Diao Q, Dai P. 2022. Combined transcriptome and metabolite profiling analyses provide insights into the chronic toxicity of carbaryl and acetamiprid to *Apis mellifera* larvae. *Nature-Scientific Reports* (2022) 12:16898. <https://doi.org/10.1038/s41598-022-21403-0>

George, T. L., L. C. McEwen, and B. E. Peterson. 1995. Effects of grasshopper control programs on rangeland breeding bird populations. *J. Range Manage.* 48:336–342.

Gilgert W. and Vaughan M. 2011. The value of pollinators and pollinator habitat to rangelands: connections among pollinators, insects, plant communities, fish, and wildlife. *Rangelands* 33(3):14–19. <https://doi.org/10.2111/1551-501x-33.3.14>

Goosey HB, Blanchette GE, Naugle DE. 2024. Pollinator response to livestock grazing: implications for rangeland conservation in sagebrush ecosystems. *Journal of Insect Science*, (2024) 24(4): 13; ieae069 <https://doi.org/10.1093/jisesa/ieae069>

Gradish, A.E., Scott-Dupree, C.D., Shipp, L. and R. Harris. 2011. Effect of reduced risk pesticides on greenhouse vegetable arthropod biological control agents. *Pest Manag. Sci.* 67: 82–86.

Guerrant, G. O., L. E. Fetzer, Jr., and J. W. Miles. 1970. Pesticide residues in Hale County, Texas, before and after ultra-low-volume aerial applications of Malathion. *Pesticide Monitoring J.* 4:14-20.

Haas J, Glaubitz J, Koenig U, Nauen R. 2022. A mechanism-based approach unveils metabolic routes potentially mediating chlorantraniliprole synergism in honey bees, *Apis mellifera* L., by azole fungicides. *Pest Manag. Sci.* 78, 965–973. <https://doi.org/10.1002/ps.6706>

Hanberry BB, DeBano SJ, Kaye TN, Rowland MM, Hartway CR, Shorrock D. 2021. Pollinators of the Great Plains: Disturbances, Stressors, Management, and Research Needs. *Rangeland Ecology & Management* 78 (2021) 220–234. <https://doi.org/10.1016/j.rama.2020.08.006>

Hannig, G.T., Ziegler, M. and P.G. Marcon. 2009. Feeding cessation effects of chlorantraniliprole, new anthralinic diamide insecticide, in comparison with several insecticides in distinct chemical classes and mode-of-action groups. *Pest Manag. Sci.* 65: 969–974.

Havstad, K. M., D. P. Peters, R. Skaggs, J. Brown, B. Bestelmeyer, E. Fredrickson, J. Herrick, and J. Wright. 2007. Ecological services to and from rangelands of the United States. *Ecological Economics* 64:261-268.

He Q, Wei Y, Wu Y, Yang Q, Wang Y, Gao Q, Xiao J, Yu L, Cao H. 2024. Does the use of chlorantraniliprole during queen development adversely impact health and viability? *Pesticide Biochemistry and Physiology* 202 DOI:10.1016/j.pestbp.2024.105920

Higley, L.G. and L.P. Pedigo (eds.). 1996. Economic thresholds for integrated pest management. University of Nebraska Press, Lincoln, Nebraska, pp. 327.

Hladik, M.L. , Vandever, M. , Smalling, K.L. , 2016. Exposure of native bees foraging in an agricultural landscape to current-use pesticides. *Science of the Total Environment* 542, 469–477. <https://doi.org/10.1016/j.scitotenv.2015.10.077>

Howe, F. P., R. L. Knight, L. C. McEwen, and T. L. George. 1996. Direct and indirect effects of insecticide applications on growth and survival of nestling passerines. *Ecol. Appl.* 6:1314-1324.

Kao, A. S. 1994. Formation and removal reactions of hazardous air pollutants. *J. Air and Waste Mgmt. Assoc.* 44:683-696.

Keever, D. W., J. R. Bradley, Jr, and M. C. Ganyard. 1977. Effects of diflubenzuron (Dimilin) on selected beneficial arthropods in cotton fields. *J. Econ. Entomol.* 6:832-836.

Kimoto C, DeBano SJ, Thorp RW, Rao S, Stephen WP. 2012. Short-term responses of native bees to livestock and implications for managing ecosystem services in grasslands. *Ecosphere* 3(10):1–19. <https://doi.org/10.1890/es12-00118.1>

Kohler M, Sturm A, Sheffield CS, Carlyle CN, Manson JS. 2020. Native bee communities vary across three prairie ecoregions due to land use, climate, sampling method and bee life history traits. *Insect Conservation and Diversity* (2020) 13, 571–584 <https://doi.org/10.1111/icad.12427>

Krueger AJ, Early TM, Ripperger RJ, Cabrera AR, Schmehl DR. 2021. The Utility of a Bumble Bee (*Bombus* spp. [Hymenoptera: Apidae]) Brood Test for Evaluating the Effects of Pesticides. *Environmental Entomology*, 50(5), 2021, 1105–1117. <https://doi.org/10.1093/ee/nvab072>

LaFleur, K. S. 1979. Sorption of pesticides by model soils and agronomic soils: rates and equilibria. *Soil Sci.* 127:94-101.

Larsen, J. and R. N. Foster. 1996. Using Hopper to Adapt Treatments and Costs to Needs and Resources. U.S. Department of Agriculture, Animal and Plant Health Inspection Service Grasshopper Integrated Pest Management User Handbook, Washington, D.C.

Larson DL, Larson JL, Buhl DA. 2018. Conserving all the pollinators: variation in probability of pollen transport among insect taxa. *Nat. Areas J.* 38(5):393–401. <https://doi.org/10.3375/043.038.0508>

Latchininsky, A., G. Sword, M. Sergeev, M. Cigiliano, and M. Lecoq. 2011. Locusts and grasshoppers: behavior, ecology, and biogeography. *Psyche* 2011:1-4.

Lockwood, J. A. and S. P. Schell. 1997. Decreasing economic and environmental costs through reduced area and agent insecticide treatments (RAATs) for the control of rangeland grasshoppers: empirical results and their implications for pest management. *J. Orthoptera Res.* 6:19-32.

Lockwood, J., S. Schell, R. Foster, C. Reuter, and T. Rahadi. 2000. Reduced agent-area treatments (RAAT) for management of rangeland grasshoppers: efficacy and economics under operational conditions. *International Journal of Pest Management* 46:29-42.

Lockwood, J. A. and A. Latchininsky. 2000. The Risks of Grasshoppers and Pest Management to Grassland Agroecosystems: An International Perspective on Human Well-Being and Environmental Health. Pages 193-215 in A. Latchininsky and M. Sergeev, editors. *Grasshoppers and Grassland Health*. Kluwer Academic Publishers.

Lockwood, J., R. Anderson-Sprecher, and S. Schell. 2002. When less is more: optimization of reduced agent-area treatments (RAATs) for management of rangeland grasshoppers. *Crop Protection* 21:551-562.

Matsumara, F. 1985. *Toxicology of insecticides*. Plenum Press, New York.

McEwen, L.C., Althouse, C.M., and Peterson, B.E., 1996. Direct and indirect effects of grasshopper integrated pest management (GHIPM) chemicals and biologicals on nontarget animal life. In U.S. Department of Agriculture, Animal and Plant Health

Inspection Service, 1996. Grasshopper Integrated Pest Management User Handbook, Tech. Bul. No. 1809. Sec. III.2. Washington, DC.

Michener C. 2007. The bees of the world. 2nd ed. Baltimore, MD: Johns Hopkins University Press.

Miles, C. J. and S. Takashima. 1991. Fate of malathion and O.O.S. trimethyl phosphorothioate byproduct in Hawaiian soil and water. *Arch. Environ. Contam. Toxicol.* 20:325-329.

Mommaerts, V., Sterk, G., and G. Smagghe. 2006. Hazards and uptake of chitin synthesis inhibitors in bumblebees *Bombus terrestris*. *Pest Mgt. Science* 62:752–758.

Murphy, C. F., P. C. Jepson, and B. A. Croft. 1994. Database analysis of the toxicity of antilocust pesticides to non-target, beneficial invertebrates. *Crop Protection* 13:413–420.

Muzzarelli, R. 1986. Chitin synthesis inhibitors: effects on insects and on nontarget organisms. *CRC Critical Review of Environmental Control* 16:141-146.

Narisu, J., A. Lockwood, and S. P. Schell. 1999. A novel mark-capture technique and its application to monitoring the direction and distance of local movements of rangeland grasshoppers (Orthoptera: Acrididae) in context of pest management. *J. Appl. Ecol.* 36:604-617.

Narisu, J., A. Lockwood, and S. P. Schell. 2000. Rangeland grasshopper movement as a function of wind and topography: implications for pest movement. *J. Appl. Ecol.* 36:604-617.

Nation, J.L., Robinson, F.A., Yu, S.J., and A.B. Bolten. 1986. Influence upon honeybees of chronic exposure to very low levels of selected insecticides in their diet. *J. Apic. Res.* 25:170–177.

Nigg, H. N., R. D. Cannizzaro, and J. H. Stamper. 1986. Diflubenzuron surface residues in Florida citrus. *Bul. Environ. Contam. Toxicol.* 36:833-838.

NIH. 2009a. Carbaryl, CASRN: 63-25-2. National Institutes of Health, U.S. National Library of Medicine, Toxnet, Hazardous Substances Database.

NIH. 2009b. National Institutes of Health, U.S. National Library of Medicine, National Center for Biotechnology Information. PubChem. <https://pubchem.ncbi.nlm.nih.gov/compound/4004>

Nogrado K, Lee S, Chon K, Lee JH. 2019. Effect of transient exposure to carbaryl wettable powder on the gut microbial community of honey bees. *Appl. Biol. Chem.* (2019) 62:6 <https://doi.org/10.1186/s13765-019-0415-7>

Norelius, E. E. and J. A. Lockwood. 1999. The effects of reduced agent-area insecticide treatments for rangeland grasshopper (Orthoptera: Acrididae) control on bird densities. *Archives of Environmental Contamination and Toxicology* 37:519-528.

Novotny JL, Hung KJ, Lybbert AH, Kaplan I, Goodell K. Short-term persistence of foliar insecticides and fungicides in pumpkin plants and their pollinators. Preprint manuscript. doi: <https://doi.org/10.1101/2024.09.24.614697>

Otto CR, Roth CL, Carlson BL, Smart MD. 2016. Land-use change reduces habitat suitability for supporting managed honey bee colonies in the Northern Great Plains. *Proceedings of the National Academy of Sciences* 113, 10430–10435. <https://doi.org/10.1073/pnas.1603481113>

Pascual, J. A. 1994. No effects of a forest spraying of malathion on breeding blue tits (*Parus caeruleus*). *Environ. Toxicol. Chem.* 13:1127–1131.

Peach, M. P., D. G. Alston, and V. J. Tepedino. 1994. Bees and bran bait: is carbaryl bran bait lethal to alfalfa leafcutting bee (Hymenoptera: Megachilidae) adults or larvae? *J. Econ. Entomol.* 87:311-317.

Peach, M. P., D. G. Alston, and V. J. Tepedino. 1995. Sublethal effects of carbaryl bran bait on nesting performance, parental investment, and offspring size and sex ratio of the alfalfa leafcutting bee (Hymenoptera: Megachilidae). *Environ. Entomol.* 24:34-39.

Pedigo, L.P., S.H. Hutchins and L.G. Higley. 1986. Economic injury levels in theory and practice. *Annual Review of Entomology* 31: 341-368.

Pfadt, R. E. 2002. Field Guide to Common Western Grasshoppers, Third Edition. Wyoming Agricultural Experiment Station Bulletin 912. Laramie, Wyoming.

Potts SG, Vulliamy B, Dafni A, et al. 2003. Linking bees and flowers: how do floral communities structure pollinator communities? *Ecology* 84(10):2628–2642. <https://doi.org/10.1890/02-0136>

Purdue University. 2018. National Pesticide Information Retrieval System. West Lafayette, IN.

Quinn, M. A., R. L. Kepner, D. D. Walgenbach, R. N. Foster, R. A. Bohls, P. D. Pooler, K. C. Reuter, and J. L. Swain. 1991. Effect of habitat and perturbation on populations and community structure of darkling beetles (Coleoptera: tenebrionidae) on mixed grass rangeland. *Environ. Entomol.* 19:1746-1755.

Rashford, B. S., A. V. Latchininsky, and J. P. Ritten. 2012. An Economic Analysis of the Comprehensive Uses of Western Rangelands. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

Raymann K, Shaffer Z, Moran NA. 2017. Antibiotic exposure perturbs the gut microbiota and elevates mortality in honeybees. *PLoS Biol* 15(3): e2001861. doi:10.1371/journal. pbio.2001861

Reinhardt, T. and R. Ottmar. 2004. Baseline measurements of smoke exposure among wildland firefighters. *Journal of Occupational and Environmental Hygiene* 1:593-606.

Reisen, F. and S. Brown. 2009. Australian firefighters' exposure to air toxics during bushfire burns of autumn 2005 and 2006. *Environment International* 35:342-353.

Relyea, R. A. and N. Diecks. 2008. An unforeseen chain of events: lethal effects of pesticides at sublethal concentrations. *Ecol. Appl.* 18:1728-1742.

Richmond, M. L., C. J. Henny, R. L. Floyd, R. W. Mannan, D. W. Finch, and L. R. DeWeese. 1979. Effects of Sevin 4-oil, Dimilin, and Orthene on Forest Birds in Northeastern Oregon. USDA, Pacific SW Forest and Range Experiment Station.

Rohde AT, Pilliod DS. 2021. Spatiotemporal dynamics of insect pollinator communities in sagebrush steppe associated with weather and vegetation. *Global Ecology and Conservation* Vol. 29. <https://doi.org/10.1016/j.gecco.2021.e01691>

Rosenberg, K. V., R. D. Ohmart, and B. W. Anderson. 1982. Community organization of riparian breeding birds: response to an annual resource peak. *The Auk* 99:260-274.

Sample, B. E., R. J. Cooper, and R. C. Whitmore. 1993. Dietary shifts among songbirds from a diflubenzuron-treated forest. *The Condor* 95:616-624.

Scott VL, Ascher JS, Griswold T, Nufio CR. 2011. The Bees of Colorado. Natural History Inventory of Colorado Number 23 September 1, 2011, University of Colorado Museum of Natural History, Boulder, Colorado. [https://www.colorado.edu/cumuseum/sites/default/files/attached-files/the\\_bees\\_of\\_colorado.pdf](https://www.colorado.edu/cumuseum/sites/default/files/attached-files/the_bees_of_colorado.pdf)

Schaefer, C. H. and E. F. Dupras, Jr. 1977. Residues of diflubenzuron [1-(4-chlorophenyl)-3(2,6-difluorobenzoyl) urea] in pasture soil, vegetation, and water following aerial applications. *J. Agric. Food Chem.* 25:1026-1030.

Shankar U. and Mukhtar Y. 2023. Pest management practices impact *Helicoverpa armigera* infestation and foraging behavior of pollinators in sunflower, *International Journal of Pest Management*, DOI: 10.1080/09670874.2023.2216667

Smith, D. and J. Lockwood. 2003. Horizontal and trophic transfer of diflubenzuron and fipronil among grasshoppers and between grasshoppers and darkling beetles (Tenebrionidae). *Archives of Environmental Contamination and Toxicology* 44:377-382.

Smith, D. I., J. A. Lockwood, A. V. Latchininsky, and D. E. Legg. 2006. Changes in non-target populations following applications of liquid bait formulations of insecticides for control of rangeland grasshoppers. *Internat. J. Pest Mgt.* 52:125-139.

Stanley, J. G. and J. G. Trial. 1980. Disappearance constants of carbaryl from streams contaminated by forest spraying. *Bul. Environ. Contam. Toxicol.* 25:771-776.

Tepedino, V. J. 1979. The importance of bees and other insect planetaries in maintaining floral species composition. *Great Basin Naturalist Memoirs* 3:139-150.

Thompson, H.M, Wilkins, S. Battersby, A.H., Waite, R.J., and D. Wilkinson. 2005. The effects of four insect growth-regulating (IGR) insecticides on honeybee (*Apis mellifera* L.) colony development, queen rearing and drone sperm production. *Ecotoxicology* 14:757-769.

Thomson, D. L. K. and W. M. J. Strachan. 1981. Biodegradation of carbaryl in simulated aquatic environment. *Bul. Environ. Contam. Toxicol.* 27:412-417.

Tuell JK, Fiedler AK, Landis D, et al. 2014. Visitation by wild and man-aged bees (Hymenoptera: Apoidea) to eastern US native plants for use in conservation programs. *Environ. Entomol.* 37(3):707-718. [https://doi.org/10.1603/0046-225x\(2008\)37\[707:vbwamb\]2.0.co;2](https://doi.org/10.1603/0046-225x(2008)37[707:vbwamb]2.0.co;2)

USDA APHIS— see U.S. Department of Agriculture, Animal and Plant Health Inspection Service

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 1999. APHIS Directive 5600.3, Evaluating APHIS programs and activities for ensuring protection of children from environmental health risks and safety risks. September 3, 1999. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Riverdale, MD. [online] available: <http://www.aphis.usda.gov/library/directives>.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2008. Grasshopper Guidebook Provisional. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2011. Report to the PPQ Management Team, Rangeland Grasshopper and Mormon Cricket Suppression Program. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2015. Biological Assessment for the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program. Page 162. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2016. APHIS Rangeland Grasshopper/Mormon Cricket Suppression Program Aerial

Application, Statement of Work. Page 39 pp. U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019. Rangeland Grasshopper and Mormon Cricket Suppression Program Final Environmental Impact Statement. United States Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019a. Human Health and Ecological Risk Assessment for Carbaryl Rangeland Grasshopper and Mormon Cricket Suppression Applications. United States Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019b. Human health and Ecological Risk Assessment for Chlorantraniliprole used in Rangeland grasshopper and Mormon Cricket Suppression Program. United States Department of Agriculture, Animal Plant and health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019c. Human Health and Ecological Risk Assessment for Diflubenzuron Rangeland Grasshopper and Mormon Cricket Suppression Applications. United States Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019d. Human Health and Ecological Risk Assessment for Malathion Rangeland Grasshopper and Mormon Cricket Suppression Applications. United States Department of Agriculture, Animal and Plant Health Inspection Service.

USDA FS— see U.S. Department of Agriculture, Forest Service

U.S. Department of Agriculture, Forest Service. 2004. Control/eradication agents for the gypsy moth—human health and ecological risk assessment for diflubenzuron (final report). United States Department of Agriculture, Forest Service

U.S. Department of Agriculture, Forest Service. 2008a. Carbaryl - Human Health and Ecological Risk Assessment (Revised Final Report). U.S. Department of Agriculture, Forest Service.

U.S. Department of Agriculture, Forest Service. 2008b. Malathion- Human Health and Ecological Risk Assessment. U.S. Department of Agriculture, Forest Service.

U.S. Department of Agriculture, Natural Resources Conservation Service.  
<https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/land/range-pasture/range-resources>

USEPA – See U.S. Environmental Protection Agency

U.S. Environmental Protection Agency. 1997. Reregistration Eligibility Decision (RED): Diflubenzuron. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2000a. Malathion Reregistration Eligibility Document Environmental Fate and Effects. Page 146. U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

U.S. Environmental Protection Agency. 2000b. Reregistration Eligibility Decision (RED) for Malathion. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2003. Environmental Fate and Ecological Risk Assessment for Re-Registration of Carbaryl. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2006. Malathion Reregistration Eligibility Document. Page 147. U.S. Environmental Protection Agency, Office of Pesticide Programs.

U.S. Environmental Protection Agency. 2007. Reregistration Eligibility Decision (RED) for Carbaryl. Page 47. U.S. Environmental Protection Agency, Prevention, Pesticides and Toxic Substances.

U.S. Environmental Protection Agency, 2008. Pesticide fact sheet: Chlorantraniliprole. Office of Prevention, Pesticides and Toxic Substances. 77 pp.

U.S. Environmental Protection Agency. 2012a. Sevin XLR Plus Label. Pages 1-40 Pesticide Product and Label System. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency, 2012b. Ecotox database accessed at:  
<http://cfpub.epa.gov/ecotox/>

U.S. Environmental Protection Agency. 2012c. Fyfanon ULV AG. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2015a. Annual Cancer Report 2015, Chemicals Evaluated for Carcinogenic Potential Page 34. U.S. Environmental Protection Agency, Office of Pesticide Programs.

U.S. Environmental Protection Agency. 2015b. Memorandum - Diflubenzuron: human health risk assessment for an amended Section 3 registration for carrot, peach subgroup 12-12B, plum subgroup 12-12C, pepper/eggplant subgroup 8010B, cottonseed subgroup 20C, alfalfa (regional restrictions) and R175 Crop Group Conversion for tree nut group 14-12. Page 71 U.S. Environmental Protection Agency, Office of Pesticide Programs.

U.S. Environmental Protection Agency. 2016a. Appendix 3-1: Environmental transport and fate data analysis for malathion. In: Biological Evaluation Chapters for Malathion ESA Assessment.

U.S. Environmental Protection Agency. 2016b. Chapter 2: Malathion Effects Characterization for ESA Assessment. In: Biological Evaluation Chapters for Malathion ESA Assessment.

U.S. Environmental Protection Agency. 2016c. Malathion: Human Health Draft Risk Assessment for Registration Review. Page 258. U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2017. Memorandum - Carbaryl: Draft Human Health Risk Assessment in Support of Registration Review. Page 113 U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2018. Preliminary Risk Assessment to Support the Registration Review of Diflubenzuron.

U.S. Fish and Wildlife Service. 2007. National Bald Eagle Management Guidelines. Page 23 pp. U.S. Department of Interior, Fish and Wildlife Service.

U.S. National Marine Fishery Service. 2009. National Marine Fisheries Service Endangered Species Act Section 7 Consultation; Final Biological Opinion for Pesticides Containing Carbaryl, Carbofuran and Methomyl. Environmental Protection Agency Registration of Pesticides Containing Carbaryl, Carbofuran and Methomyl. U.S. Department of Commerce, National Marine Fisheries Service.

Wade A, Lin C-H, Kurkul C, Regan ER, Johnson RM. Combined toxicity of insecticides and fungicides applied to California almond orchards to honey bee larvae and adults. *Insects*. 2019; 10: 20. <https://doi.org/10.3390/insects10010020>

Wakeland, C. and W. E. Shull. 1936. The Mormon cricket with suggestions for its control, Extension Bulletin No. 100. University of Idaho, College of Agriculture, Idaho Agricultural Extension.

Williams JR, Swaleb DR, Anderson TD. 2020. Comparative effects of technical-grade and formulated chlorantraniliprole to the survivorship and locomotor activity of the honey bee, *Apis mellifera* (L.). Pest Management Science 76:8, 2582-2588 (2020). <https://scijournals.onlinelibrary.wiley.com/doi/full/10.1002/ps.5832>

Yang Y, Ma S, Liu F, Wang Q, Wang X, Hou C, Wu Y, Gao J, Zhang L, Liu Y, Diao Q, Dai P. 2019. Acute and chronic toxicity of acetamiprid, carbaryl, cypermethrin and deltamethrin to *Apis mellifera* larvae reared in vitro. Pest Manag. Sci. (2020)76, 978–985. <https://doi.org/10.1002/ps.5606>

Zinkl, J. G., C. J. Henny, and L. R. DeWeese. 1977. Brain cholinesterase activities of birds from forests sprayed with trichlorfon (Dylox) and carbaryl (Sevin 4-oil). Bul. Environ. Contam. Toxicol. 17:379-386.

## VI. Listing of Agencies and Persons Consulted

### **Bureau of Land Management**

Christina Rhyne, Rangeland Management Specialist, Little Snake Field Office, 455 Emerson St., Craig, CO 81625

John Ring, Forestry Program Lead - ESR State Coordinator - Noxious Weeds and Invasive Species Program Lead, 2850 Youngfield St, Lakewood, CO 80215

Matthew Dupire, Wildlife Biologist, White River Field Office, 220 East Market Street, Meeker, CO 81641

### **Colorado Department of Agriculture**

Wondirad Gebru, Plant Industry Division Director, 305 Interlocken Parkway, Broomfield, CO 80021

### **Colorado Division of Wildlife**

6060 Broadway, Denver, CO 80216

Mike Grode, Habitat Supervisor\*

Francie Pusateri, Biologist\*

Pam Schnurr Biologist\*

Jeff Yost, Terrestrial Biologist\*

### **Moffat County**

Jesse Schroeder, Pest Management Manager, 539 Barclay St., Craig, CO 81625

### **Rio Blanco County**

Jane Turnburke, Weed Control Supervisor, 779 Sulphur Creek Road, Meeker, CO 81641

### **USDA APHIS PPQ**

4700 River Rd Unit 134 Riverdale, MD 20737

Bill Wesela, National Grasshopper Program Policy Manager

Jim Warren, Environmental Protection Specialist

Kai Caraher, Biological Scientist

Tracy Willard, Environmental Protection Specialist

Charles Brown, National Policy Manager\*

3950 N. Lewiston Street, Aurora, CO 80011

Elvir Tenic, State Plant Health Director

Patrick McPherren, State Plant Health Director\*

### **US Fish and Wildlife Service**

445 Gunnison Ave, Grand Junction, CO 81501

Kathie Gissing, Wildlife Biologist

Gail Martinez, Wildlife Biologist\*

J. Creed Clayton, Acting COFO Western Team Supervisor\*

\*Indicates past consultation

**Appendix A**  
**APHIS Rangeland Grasshopper and Mormon Cricket Suppression**  
**Program**  
**FY-2025 Treatment Guidelines**  
**Version 01/09/2023**

The objectives of the APHIS Rangeland Grasshopper and Mormon Cricket Suppression Program are to 1) conduct surveys in the Western States; 2) provide technical assistance to land managers and private landowners; and 3) when funds permit, suppress economically damaging grasshopper and Mormon cricket outbreaks on Federal, Tribal, State, and/or private rangeland. The Plant Protection Act of 2000 provides APHIS the authority to take these actions.

**General Guidelines for Grasshopper / Mormon Cricket Treatments**

1. All treatments must be in accordance with:
  - a. the Plant Protection Act of 2000;
  - b. applicable environmental laws and policies such as: the National Environmental Policy Act, the Endangered Species Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Clean Water Act (including National Pollutant Discharge Elimination System requirements – if applicable);
  - c. applicable state laws;
  - d. APHIS Directives pertaining to the proposed action;
  - e. Memoranda of Understanding with other Federal agencies.
2. Subject to the availability of funds, upon request of the administering agency, the agriculture department of an affected State, or private landowners, APHIS, to protect rangeland, shall immediately treat Federal, Tribal, State, or private lands that are infested with grasshoppers or Mormon crickets at levels of economic infestation, unless APHIS determines that delaying treatment will not cause greater economic damage to adjacent owners of rangeland. In carrying out this section, APHIS shall work in conjunction with other Federal, State, Tribal, and private prevention, control, or suppression efforts to protect rangeland.
3. Prior to the treatment season, conduct meetings or provide guidance that allows for public participation in the decision-making process. In addition, notify Federal, State and Tribal land managers and private landowners of the potential for grasshopper and Mormon cricket outbreaks on their lands. Request that the land manager / landowner advise APHIS of any sensitive sites that may exist in the proposed treatment areas.
4. Consultation with local Tribal representatives will take place prior to treatment programs to fully inform the Tribes of possible actions APHIS may take on Tribal lands.
5. On APHIS run suppression programs and subject to funding availability, the Federal government will bear the cost of treatment up to 100 percent on Federal and Tribal Trust

land, 50 percent of the cost on State land, and 33 percent of cost on private land. There is an additional 16.15% charge, however, on any funds received by APHIS for federal involvement with suppression treatments.

6. Land managers are responsible for the overall management of rangeland under their control to prevent or reduce the severity of grasshopper and Mormon cricket outbreaks. Land managers are encouraged to have implemented Integrated Pest Management Systems prior to requesting a treatment. In the absence of available funding or in the place of APHIS funding, the Federal land management agency, Tribal authority or other party/ies may opt to reimburse APHIS for suppression treatments. Interagency agreements or reimbursement agreements must be completed prior to the start of treatments which will be charged thereto.
7. There are situations where APHIS may be requested to treat rangeland that also includes small areas where crops are being grown (typically less than 10 percent of the treatment area). In those situations, the crop owner pays the entire treatment costs on the croplands.

NOTE: The insecticide being considered must be labeled for the included crop as well as rangeland and current Worker Protection Standards must be followed by the applicator and private landowner.

8. In some cases, rangeland treatments may be conducted by other federal agencies (e.g., Forest Service, Bureau of Land Management, or Bureau of Indian Affairs) or by non-federal entities (e.g., Grazing Association or County Pest District). APHIS may choose to assist these groups in a variety of ways, such as:
  - a. loaning equipment (an agreement may be required);
  - b. contributing in-kind services such as surveys to determine insect species, instars, and infestation levels;
  - c. monitoring for effectiveness of the treatment;
  - d. providing technical guidance.
9. In areas considered for treatment, State-registered beekeepers and organic producers shall be notified in advance of proposed treatments. If necessary, non-treated buffer zones can be established.

## **Operational Procedures**

### ***GENERAL PROCEDURES FOR ALL AERIAL AND GROUND APPLICATIONS***

1. Follow all applicable Federal, Tribal, State, and local laws and regulations in conducting grasshopper and Mormon cricket suppression treatments.
2. Notify residents within treatment areas, or their designated representatives, prior to proposed operations. Advise them of the control method to be used, proposed method of application, and precautions to be taken.

3. One of the following insecticides that are labeled for rangeland use can be used for a suppression treatment of grasshoppers and Mormon crickets:
  - A. Carbaryl
    - a. solid bait
    - b. ultra-low volume (ULV) spray
  - B. Diflubenzuron ULV spray
  - C. Malathion ULV spray
  - D. Chlorantraniliprole spray
4. Do not apply insecticides directly to water bodies (defined herein as reservoirs, lakes, ponds, pools left by seasonal streams, springs, wetlands, and perennial streams and rivers).

Furthermore, provide the following buffers for water bodies:

- 500-foot buffer with aerial liquid insecticide.
- 200-foot buffer with ground liquid insecticide.
- 200-foot buffer with aerial bait.
- 50-foot buffer with ground bait.

5. Instruct program personnel in the safe use of equipment, materials, and procedures; supervise to ensure safety procedures are properly followed.
6. Conduct mixing, loading, and unloading in an approved area where an accidental spill would not contaminate a water body.
7. Each aerial suppression program will have a Contracting Officer's Representative (COR) OR a Treatment Manager on site. Each State will have at least one COR available to assist the Contracting Officer (CO) in GH/MC aerial suppression programs.

NOTE: A Treatment Manager is an individual that the COR has delegated authority to oversee the actual suppression treatment; someone who is on the treatment site and overseeing / coordinating the treatment and communicating with the COR. No specific training is required, but knowledge of the Aerial Application Manual and treatment experience is critical; attendance to the Aerial Applicators Workshop is very beneficial.

8. Each suppression program will conduct environmental monitoring as outlined in the current year's Environmental Monitoring Plan.

APHIS will assess and monitor rangeland treatments for the efficacy of the treatment, to verify that a suppression treatment program has properly been implemented, and to assure that any environmentally sensitive sites are protected.

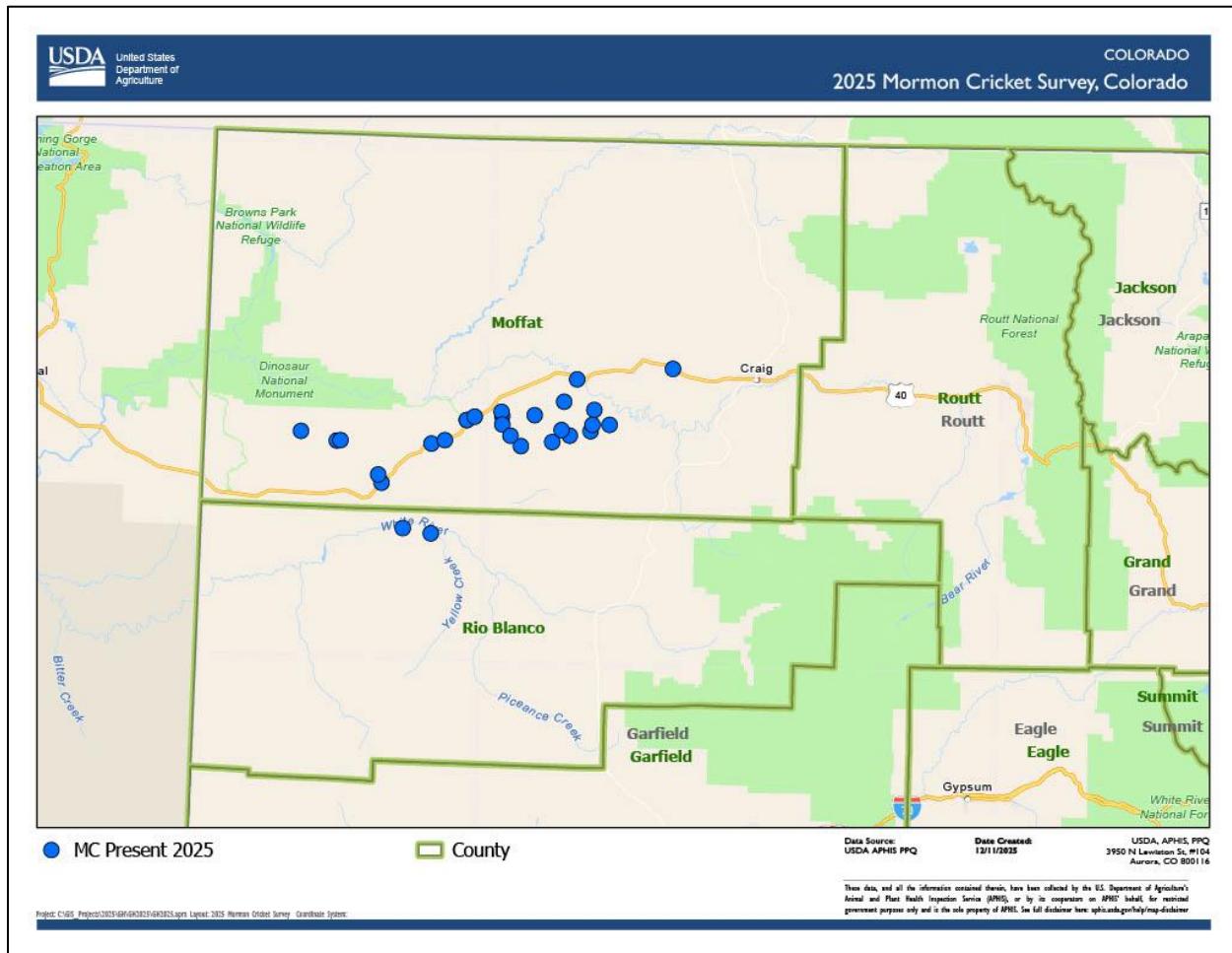
9. APHIS reporting requirements associated with grasshopper / Mormon cricket suppression treatments include:
  - A. Completion of a post-treatment report (Part C of the Project Planning and Reporting Worksheet (PPQ Form 62)

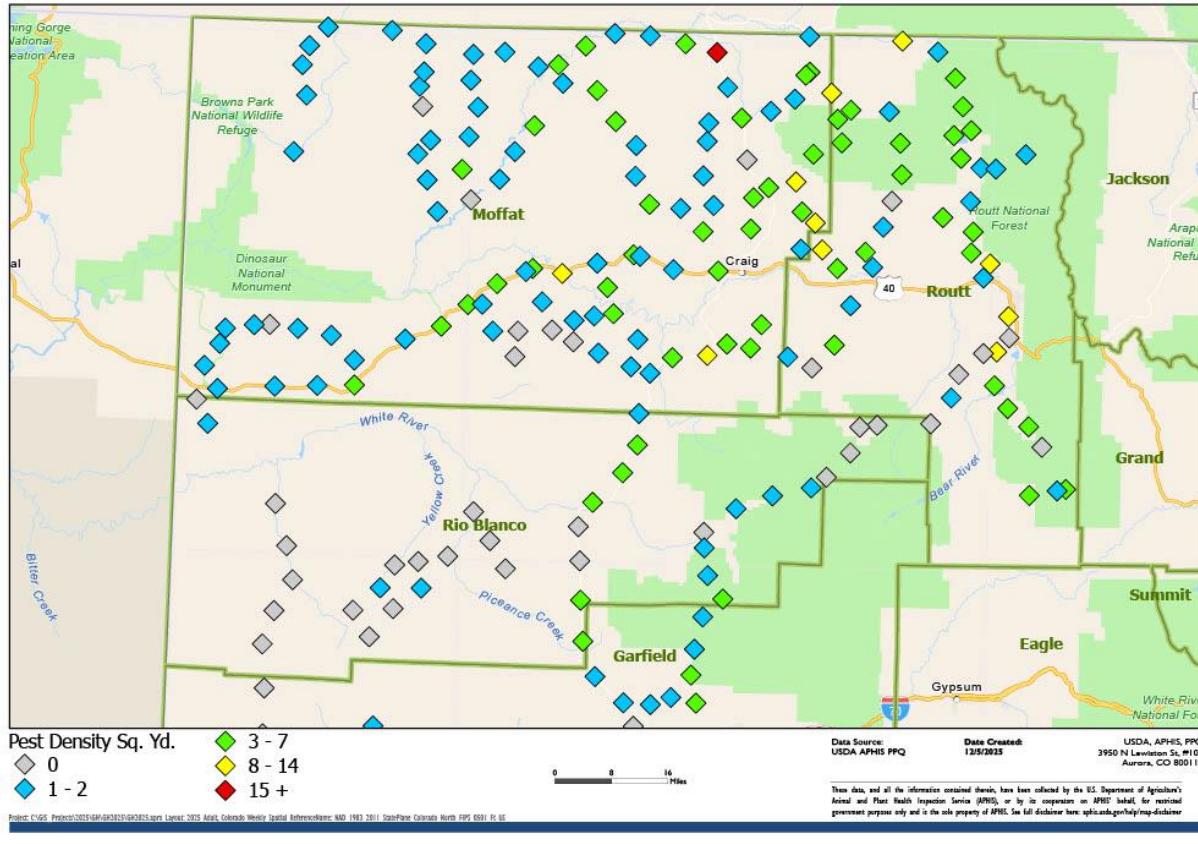
- B. Providing an entry for each treatment in the PPQ Grasshopper/Mormon Cricket treatment database
- C. For aerial treatments, providing copies of forms and treatment/plane data for input into the Federal Aviation Interactive Reporting System (FAIRS) by PPQ's designee

#### ***SPECIFIC PROCEDURES FOR AERIAL APPLICATIONS***

1. APHIS Aerial treatment contracts will adhere to the current year's Statement of Work (SOW).
2. Minimize the potential for drift and volatilization by not using ULV sprays when the following conditions exist in the spray area:
  - a. Wind velocity exceeds 10 miles per hour (unless state law requires lower wind speed);
  - b. Rain is falling or is imminent;
  - c. Dew is present over large areas within the treatment block;
  - d. There is air turbulence that could affect the spray deposition;
  - e. Temperature inversions (ground temperature higher than air temperature) develop and deposition onto the ground is affected.
3. Weather conditions will be monitored and documented during application and treatment will be suspended when conditions could jeopardize the correct spray placement or pilot safety.
4. Application aircraft will fly at a median altitude of 1 to 1.5 times the wingspan of the aircraft whenever possible or as specified by the COR or the Treatment Manager.
5. Whenever possible, plan aerial ferrying and turnaround routes to avoid flights over congested areas, water bodies, and other sensitive areas that are not to be treated.

## Appendix B: Map of the Affected Environment





## Appendix C: Summary of Protection Measures (treatment buffers) for Listed Species

Species	Carbaryl ULV	Carbaryl bait	Diflubenzuron ULV
Mexican spotted owl	A 500 ft. ground/aerial buffer will be used at the perimeter of known locations and critical habitat.	A 500 ft. ground/aerial buffer will be used at the perimeter of known locations and critical habitat.	A 500 ft. ground/aerial buffer will be used at the perimeter of known locations and critical habitat.
Whooping crane	500 ft. ground buffer and 0.5 mi aerial buffer at the edge of known locations of whooping cranes or their critical habitat	500 ft. ground buffer and 750 ft. aerial buffer at the edge of known locations of whooping cranes or their critical habitat	500 ft. ground buffer and 1000 ft. aerial buffer at the edge of known locations of whooping cranes or their critical habitat
Yellow-billed cuckoo	500 ft. ground buffer and 1320 ft. aerial buffer at the edge of known locations of yellow-billed cuckoos or their critical habitat	500 ft. ground buffer and 750 ft. aerial buffer at the edge of known locations of yellow-billed cuckoos or their critical habitat	500 ft. ground buffer and 1000 ft. aerial buffer at the edge of known locations of yellow-billed cuckoos or their critical habitat
Bonytail	2,640 ft. aerial/300 ft. ground	750 ft. aerial/ 100 ft. ground	1320 ft. aerial/200 ft. ground
Colorado pikeminnow	2,640 ft. aerial/300 ft. ground	750 ft. aerial/ 100 ft. ground	1320 ft. aerial/200 ft. ground
Humpback chub	2,640 ft. aerial/300 ft. ground	750 ft. aerial/ 100 ft. ground	1320 ft. aerial/200 ft. ground
Pallid sturgeon	2,640 ft. aerial/300 ft. ground	750 ft. aerial/ 100 ft. ground	1320 ft. aerial/200 ft. ground
Razorback sucker	2,640 ft. aerial/300 ft. ground	750 ft. aerial/ 100 ft. ground	1320 ft. aerial/200 ft. ground
Dudley Bluffs bladderpod	1 mile aerial/ground April through May	RAAT applications only aerial/ ground 50 ft	RAAT applications only aerial/ ground 50 ft
Dudley Bluffs twinpod	1 mile aerial/ground April through May	RAAT applications only aerial/ ground 50 ft	RAAT applications only aerial/ ground 50 ft
Parachute beardtongue	1 mile aerial/ground June through July	RAAT applications only aerial/ ground 50 ft	RAAT applications only aerial/ ground 50 ft
Ute ladies'-tresses	1 mile aerial/ground July through August	RAAT applications only aerial/ ground 50 ft	RAAT applications only aerial/ ground 50 ft
Western prairie fringed orchid	1 mile aerial/ground June through July	RAAT applications only aerial/ ground 50 ft	RAAT applications only aerial/ ground 50 ft