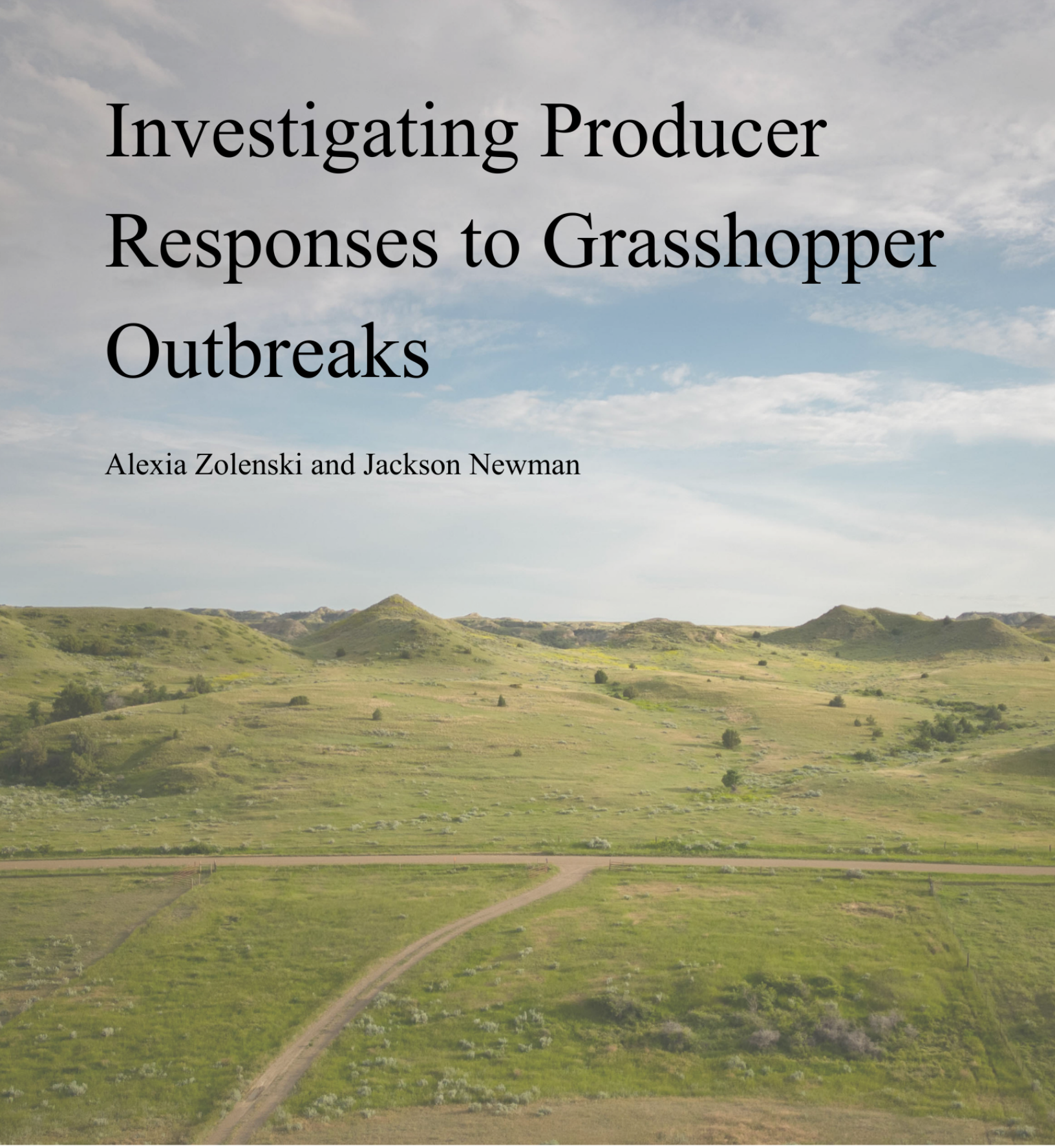
# Investigating Producer Responses to Grasshopper Outbreaks

Alexia Zolenski and Jackson Newman



Ucross High Plains Stewardship

Yale SCHOOL OF THE ENVIRONMENT

# TABLE OF CONTENTS


AUTHORS ..... 3

ACKNOWLEDGEMENTS ..... 3

INTRODUCTION ..... 4

METHODS ..... 7

RESULTS AND DISCUSSION ..... 8

**Outbreaks Pose an Economic Threat to Producers' Operations, Causing Producers Increased Stress** ..... 8

Threat Severity ..... 8

Economic Damages ..... 9

Increased Stress ..... 9

Resignation to the Existence of Grasshoppers ..... 10

**Producer Responses to Outbreaks is Varied** ..... 10

Spraying Is Perceived to Be Most Effective ..... 10

A Holistic Approach ..... 11

**Producers View Outbreaks as a Community Problem Necessitating a Community-Based Solution** ..... 13

A Community Problem ..... 13

Even Spraying Has Constraints ..... 13

A Community Solution ..... 14

**Scientific Uncertainty Around Grasshopper Behavior Remains** ..... 15

Scientific Uncertainty ..... 16

CONCLUSION ..... 17

WORKS CITED ..... 18

APPENDIX A ..... 20

APPENDIX B ..... 21

# AUTHORS

Alexia Zolenski
Juris Doctor Candidate, Master of Environmental Management Candidate ‘27
Vermont Law School / Yale School of the Environment
alexia.zolenski@yale.edu

Jackson Newman
Master of Environmental Management Candidate ‘27
Yale School of the Environment
jack.newman@yale.edu

# ACKNOWLEDGEMENTS

We would like to sincerely thank all producers who took valuable time out of their days to share their experiences with us. We would also like to thank our supervisor, Michelle Downey, our principal investigator, Li Murphy, and others who reviewed this work in both the research and writing phases. Their support and expertise were invaluable throughout this process.

# INTRODUCTION

Grasshoppers are herbivores abundant across North American dryland habitats, primarily grasslands (Branson et al. 2006). Although more than 400 species occur in these landscapes, only 15 species are considered "economically damaging," with four Acrididae species (*Melanoplus sanguinipes*, *Melanoplus bivittatus*, *Melanoplus differentialis*, and *Melanoplus femurrubrum*) causing the most agricultural damage (Rodbell et al. 2025). These species consume host plants, reducing crop yields and forage available for livestock. In a typical year, estimates of annual forage loss range between 20 and 25%, with economic losses estimated around 400 million dollars (Montana State University 2026; Rodbell et al. 2025). While grasshoppers themselves may seem small, their impacts pose a significant challenge for western communities, especially agricultural producers who rely on forage to maintain their livestock. This has led to a collective effort, including major federal agencies, organizations, research institutions, and producers themselves, to understand the best way to mitigate periodic widespread outbreaks.

While grasshopper outbreaks are a notorious part of western history, the suite of control methods available to producers has not significantly advanced over time. When dealing with vast swarms of Rocky Mountain locust (*Melanoplus spretus*) in the mid-to-late nineteenth century, governments and individuals devised tactics not dissimilar to those available today: swatting at the insects, smoking them out, locust-crushing machines, horse-drawn flamethrowers, flooding, plowing, poisoning, diversifying their operations, monetary aid, and appeals to God (Lockwood 2004) (Fig. 1).


***Figure 1. Grangers versus grasshoppers, or the irrepressible conflict****. Political cartoons of the mid- to late-19th century frequently highlighted human-hopper conflict (Nicollet County Historical Society).*

Today, the most well-known modern control method, insecticide application, can be implemented privately or in coordination with the U.S. Department of Agriculture's Animal & Plant Health Inspection Service (APHIS), the federal agency tasked with controlling grasshoppers pursuant to § 7717 of the Plant Protection Act. The Act mandates the Secretary "carry out a program to control grasshoppers and Mormon crickets on all Federal lands *to protect rangeland*" (Plant Protection Act).[1] Further, the Act implements a robust cost-sharing scheme, with 100% of treatment costs covered on federal and Tribal Trust rangeland, 50% covered on state land, and 33.3% covered on private land (Plant Protection Act).

Historically, the agency's preferred approach has consisted of applying insecticides, which come as baits or sprays and can be applied on the ground or aerially (APHIS 2019).[2] These insecticides target various grasshopper life stages, with APHIS-preferred insecticides carbaryl targeting the nervous system and diflubenzuron (common name Dimilin®) inhibiting growth (APHIS 2019). Before treating, APHIS surveys the area to ensure they meet the economic threshold for taking action, which is eight grasshoppers per square yard (APHIS 2019) (Rodbell et al. 2025). According to their latest Environmental Impact Statement, they also incorporate other economic and ecological considerations to determine whether treatment would be effective (APHIS 2019). When treatment is deemed necessary, APHIS prefers following the Reduced Area and Agent Treatment (RAATs) technique, which usually involves applying less insecticide overall through alternating swaths of treated and untreated land in hopes of reducing total application area and risks to non-target organisms (APHIS 2019). The most commonly applied insecticide is Dimilin®, prized for its selectivity towards egg and juvenile life stages as it arrests development by preventing formation of the larval arthropod exoskeleton.

While APHIS follows Environmental Protection Agency (EPA) and state label instructions regarding each insecticide's use, the agency itself has appreciated the risks inherent in insecticide application—even for more selective options (APHIS 2019). Insecticides pose risks to non-target pollinators, worms, birds, and aquatic species, accelerating biodiversity loss (Wan et al. 2025). Those with longer half-lives (a measure of the time required for a substance's degradation) "are more likely to accumulate if there are repeated applications and may cause increased risks of contaminating surface and ground water, plants, and animals" (APHIS 2019). These risks are compounded by uncertainty; due to lack of information, some individual and cumulative effects remain unknown (APHIS 2019). At the same time, grasshoppers can provide many beneficial ecosystem services, serving as a vital food source and accelerating nutrient cycling, which could enhance forage production in the long-term (Belovsky & Slade 2000).

Due to these risks, researchers have proposed alternative control methods such as cultural[3] and mechanical control (Fig. 2) (Rodbell et al. 2025; Branson et al. 2006; Onsager 2000). In addition

[1] Note that the phrase "to protect rangeland" inhibits APHIS from cost-sharing treatment of private crop land (APHIS 2019). If small amounts of crop land are smattered within a rangeland treatment block, however, the agency will treat the whole block to maintain continuity (APHIS 2019). It will also treat on the border, where eligible rangeland immediately abuts private crop land (APHIS 2019).

[2] In 2025, the U.S. District Court for the District of Oregon held that APHIS must consider control methods beyond insecticide application and incorporate integrated pest management (IPM) into its treatment approach (*Xerces Society for Invertebrate Conservation v. Shea* 2025).

[3] The phrase "cultural control" refers to the Integrated Pest Management (IPM) strategy of modifying the growing environment to reduce attractiveness to "pests."

to alternatives like changing seeding strategy and reducing livestock stocking rates, more thoroughly investigated alternatives include changing grazing strategy and habitat manipulation via fire. In 2000, entomologist Jerome Onsager compared grasshopper abundance on season-long grazed rangeland with twice-over rotationally grazed rangeland in the northern Great Plains (Onsager 2000). Compared to rotational grazing, "seasonal presence of all grasshopper species combined averaged 3.3X higher under season-long grazing" (Onsager 2000). In 1996, Eric Porter and Richard Redak investigated the effect of a spring prescribed burn on grasshoppers in a California native grassland (Porter & Redak 1996). While grasshopper density and biomass returned to normal two years later, grasshopper density and biomass decreased both the year of the burn and one year post-burn (Porter & Redak 1996). These studies might suggest that producers should diversify their control of choice.

However, other studies observed no difference or even an increase in grasshopper abundance following prescribed fire (Vermiere et al. 2004; Joern 2004; Joern 2005). Further, Onsager stipulates that "[c]oncepts and technologies developed for grasshopper management in the northern Great Plains probably will not transfer directly to Palouse prairie, intermountain sagebrush, or shortgrass prairie ecosystems" (Onsager 2000). The sheer diversity of western ecosystems leads to uncertainty. Demonstrating the efficacy of any alternative control method would require long-term studies, and as Branson, Joern, & Sword note, "[s]uch large-scale, long-term, experimental examinations of habitat manipulation practices are expensive and require consistent management, making them logistically difficult" (Branson, Joern & Sword 2006). Further, grasshoppers are under researched. While studies have attempted to define the factors distinguishing an outbreak year from a normal year (e.g., temperature, soil moisture, and canopy cover) even APHIS still struggles to predict bad years (Kistner-Thomas et al. 2021).

***Figure 2. Alternatives to chemical control.*** *A range of alternatives to chemical control exist, with varying levels of economic feasibility (Rodbell et al. 2025; Branson et al. 2006).*

| Type | Method | |
|---|---|---|
| | Cropland | Rangeland |
| Cultural | using alternative seeding strategies, rotating crops, changing crop type, being aware of crop locations, trap strips/trap crops, row covers, barrier strips, changing harvest timing, increasing the abundance of natural enemies | increasing plant density, diversifying pasture species, reducing stocking rate, changing grazing timing, using rotational grazing, integrating poultry, pasture renovation, increasing the abundance of natural enemies |
| Mechanical | tilling fields, fallowing fields, applying prescribed fire | applying prescribed fire |

To examine these dynamics, both the effects of grasshopper outbreaks and the complexities inherent in addressing them, we went straight to those most economically affected: producers.

The following report summarizes the findings of a year-long pilot study investigating producer responses to grasshopper outbreaks in central and eastern Montana and eastern Oregon. Given the relatively small sample size of the surveys and interviews, none of these takeaways should be interpreted as representative of all producers. This report is meant as a preliminary effort to engage producers, identify some common themes in responses, and hopefully guide future scholarship that is more rigorous and wide ranging.

# METHODS

We investigated the response of producers to grasshopper outbreaks by distributing a fifteen-question online survey and conducting semi-structured virtual/phone interviews with livestock producers in 2025-2026. Producers are defined as persons managing cattle for commercial purposes. Some of the producers we interviewed also have roles as land management professionals for various government agencies. The target geographic area was eastern Montana and eastern Oregon due to their histories of grasshopper outbreaks. We contacted a wide variety of organizations and asked them to distribute the survey to producers. The survey link was shared with producers through non-profit ranching organizations, conservation districts, government agencies, and personal networks. However, responses to both the survey and volunteers for interviews were comprised mostly of producers from eastern Montana, which we suspect is due to the strength of personal networks that were forged by team members who worked in Montana previously.

The online survey collected information from 31 participants on their experience with grasshopper outbreaks and their land management choices. However, not all survey respondents answered every question in the survey leading to lower response rates in the graphs below. The survey served dual functions for data collection: 1) the survey was an intake mechanism to find producers within our target area who were willing to be further interviewed by our team and 2) the survey provided quantitative data related to our research questions.

The semi-structured interviews were comprised of twelve open-ended questions and were conducted and recorded over Zoom, lasting around an hour each. Most interviews were scheduled via survey responses or using the snowball method. The snowball method is when interviewees recommend other subjects to contact for the study. We conducted ten semi-structured interviews with producers to gain insights into their experiences and attitudes towards grasshopper outbreaks. Not all interviewees completed the survey. Analysis consisted of transcribing the interviews and reviewing them for patterns, with a focus on determining the key points of each response, along with any additional concepts or themes that emerged. Again, given the small sample size of the surveys and interviews, our conclusions are only representative of producers that we engaged should not be considered statistically significant.

The interview guide was approved by the Yale University Institutional Review Board. Both the survey and our interview guide can be found in the appendix of the report (Appendix A).

# RESULTS AND DISCUSSION

## *Outbreaks Pose an Economic Threat to Producers' Operations, Causing Producers Increased Stress*

### Threat Severity

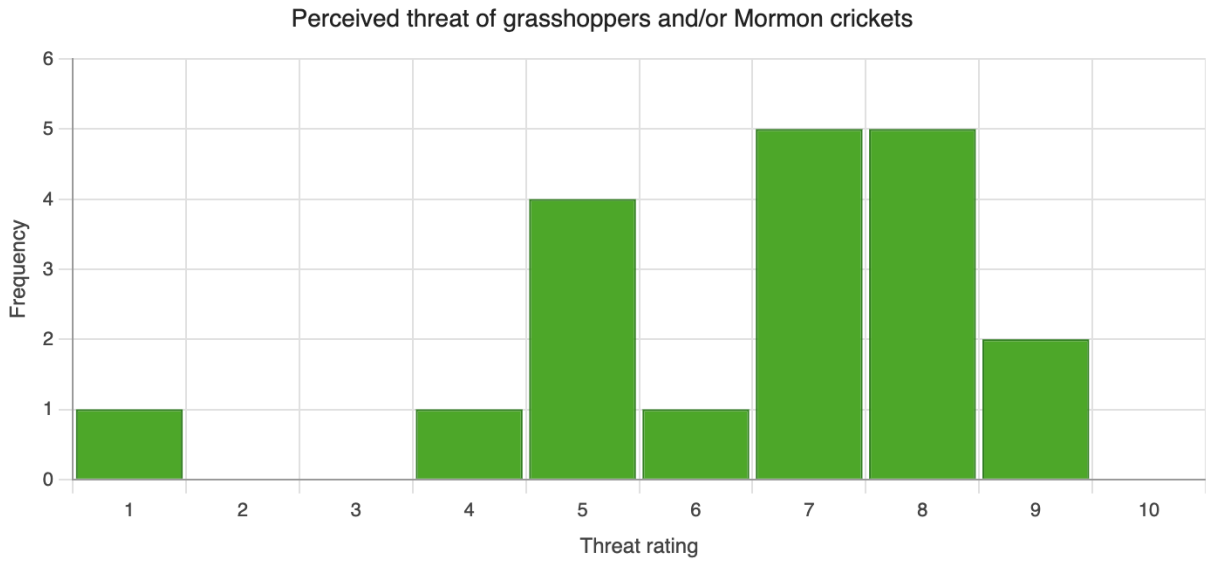



***Figure 3. Threat severity.*** *Results of survey respondents (n=19) ranking the severity of grasshoppers and/or Mormon crickets as a threat to their operation, 0 being not a threat, 10 being greatest threat.*

Of survey respondents (*n*=19) ranking the severity of grasshoppers and/or Mormon crickets as a threat to their operation (0 being not a threat, 10 being greatest threat), most producers ranked grasshoppers more threatening than not. Overall, 68% of respondents ranked the threat higher than average, with most respondents characterizing the threat as a 7 or an 8 (26% each) on the 0-10 scale (Fig. 3).

Producers may have been more inclined to fill out the survey if they previously experienced grasshopper impacts, introducing potential bias. Interviews with producers both confirmed and contradicted survey results. While some characterized the threat as "pretty high," others noted there are "bigger fish to fry." During the outreach process, one organization contacted declined to participate, citing a slew of other issues producers face. Consistent with survey responses, however, one producer deemed grasshoppers "the dominant force on our landscape…more so than the weather, more so than snow," remarking that "[w]e've never had a nuclear war, but that's the only thing I can imagine that would be more dominant than grasshopper plagues." These results suggest that both the perceived and actual threat posed by grasshoppers varies geographically, even within a single state's boundaries.

***"We've never had a nuclear war, but that's the only thing I can imagine that would be more dominant than grasshopper plagues."***

## Economic Damages

Grasshopper outbreaks impact producers' day-to-day lives. Of survey respondents, 84% had to change something about their operation as a result of an outbreak. Of note, some producers who ranked grasshoppers as a below average threat still initiated changes, while others who ranked grasshoppers as an above average threat made no change at all. This anomaly could reflect the intermittent nature of grasshopper outbreaks (i.e., an outbreak year initiating temporary operational change but not enough to qualify as a long-term threat). It could also reflect uncertainty. One producer noted that "they've been such a presence that people just kind of took a deep breath and said, [expletive], we hopefully will live through it, because they just couldn't figure out how to strategically and economically apply a control that they could either afford or get done in the most appropriate way."

***"People just kind of took a deep breath and said, [expletive], we hopefully will live through it, because they just couldn't figure out how to strategically and economically apply a control that they could either afford or get done in the most appropriate way."***

Across survey responses and interviews with producers, the most common changes initiated were destocking and purchasing supplemental feed. Of survey respondents ($n$=16), 44% destocked (including reducing overall herd size, selling calves earlier, retaining fewer heifers for the subsequent year, and changing stocking rate). For existing stock, producers manipulated grazing strategy and timing by removing cattle from pasture, avoiding heavily affected pastures, introducing "management restrictions for particular areas," grazing earlier, shortening the grazing season overall, feeding hay sooner, and weaning calves earlier. Some producers stressed maintenance of a healthy grassland, including minimizing bare ground and overgrazing, as a long-term management practice. Many producers cited treatment itself as an operational change, including aerial spray. One producer noted a limited return on investment, bearing "more cost due to spray to not even maintain the outbreak." Other costs borne due to grasshopper presence include increased cost of hay for the winter (due to decreased supply), the addition of fertilizer enhanced with microbial additives (to reduce grasshopper impacts on hay crops), and increased protein supplement cost (due to grasshoppers' selective grazing of high-protein forage).

## Increased Stress

In addition to physical harms, the presence of grasshoppers can introduce emotional strain. One producer noted that "there's a lot of stress when they're around in high concentrations." Another remarked that "[a] lot of the damage grasshoppers do, just like droughts or anything else, is psychological…If you sit there, and you're watching the grasshoppers, and you're thinking, God, they're eating all my grass…your ability to…think clearly really goes down." The role these psychological harms play in choosing whether or not to initiate treatment, including their role in community dynamics, warrants further investigation.

***"A lot of the damage grasshoppers do, just like droughts or anything else, is psychological."***

Overall, grasshopper outbreaks impact producers, forcing operational changes that pinch producers economically and inducing stress tantamount to that pinch.

## Resignation to the Existence of Grasshoppers

A prevailing attitude amongst producers we interviewed was that they do not like grasshoppers, but there is some resignation to their existence. As one producer explained, "It's fine to have a few of them, but when they have an outbreak year, it feels like they're just stealing from you. Or worse, they're stealing from your ground and your livestock. So there's a reason that they use them as an example of a bad thing in the Bible, because they're bad." Another producer added "I've never heard anyone say there's any particular benefit to having grasshoppers, even just a few. Unless you're raising blackbirds, I guess."

***"So there's a reason that they use them as an example of a bad thing in the Bible, because they're bad."***

And yet, many producers still see them as part a natural part of the ecosystem, "There are times that I do resent them and feel that they're pests and feel that we're competing for the same resource. It's hard not to feel that way when they're eating everything. But then I also feel like they are part of this system." Another producer explained, "Nature decided to have these exist and we should just be really careful when we do choose to bring in some kind of an agent to control them." This tension was reflected in many of the interviews we conducted.

# *Producer Responses to Outbreaks is Varied*

## Spraying Is Perceived to Be Most Effective

Producers noted that there are a variety of techniques to respond to grasshopper and Mormon cricket outbreaks. Spraying pesticide was the technique that most survey respondents were aware of (71%), implemented (50%), and believed to be effective (53%) (Fig. 4). As one producer said, "I think the best [technique] that we have right now is Dimlin in a strip pattern spraying… if we have a really bad outbreak year and we spray them, we don't normally see them in that area for 2 to 3 years." Other well-known techniques included changing grazing timing, rotational grazing, and diversifying pasture plant species. However, according to survey respondents, these techniques were deemed less effective than spraying.

***"When they have an economic impact, there's a bottom line that we have to figure in, and so it comes down to that sometimes."***

Despite its perceived efficacy, several producers expressed concern about negative externalities related to spraying pesticides. As a producer explained, "I think both years I sprayed, it was effective, and maybe that's why I didn't see as many issues after. I don't know for sure. I haven't

sprayed since, and I would really like to not do that, because I'm concerned about the effects on other things." Another producer continued, "I think most producers now appreciate the importance of insects and the importance of diversity. It's just like, if it's such a level of impact that if I don't control it that I'm really gonna get hurt, I'm going to spray." Another producer added, "when they have an economic impact, there's a bottom line that we have to figure in, and so it comes down to that sometimes." They continued, "I remember my uncle saying... what are you gonna do? And I said, 'I don't know. I don't know if I can afford [spraying]. And he said, 'I don't know if you can afford not to.'" Other reasons for participating in sprays included social pressure. One producer included, "I wouldn't necessarily want our property sprayed, but I still might entertain it if it looks like we're about to be ostracized from the community for not doing it." Overall, many producers were skeptical about spraying pesticides but did not see an effective or economical alternative. Most alternatives were deemed by producers to be unproven, ineffective, and/or costly.

## A Holistic Approach

Several producers took a holistic approach to grasshopper control positing that focusing on overall grassland health would make for more resiliency to outbreaks. One producer explained, "Having healthy soil ties to healthy plants. It's just common sense, you know? If you're eating well, and you're healthy, and you're taking care of yourself, you probably won't get as sick as someone who's kinda hungry or stressed." Another interviewee stressed that, "If you have a healthy, resilient grassland, it's going to be way less vulnerable to grasshoppers. That doesn't mean you're not going to have them, but I think that the damage they're going to do to you is going to be much less in a really healthy, resilient grassland."

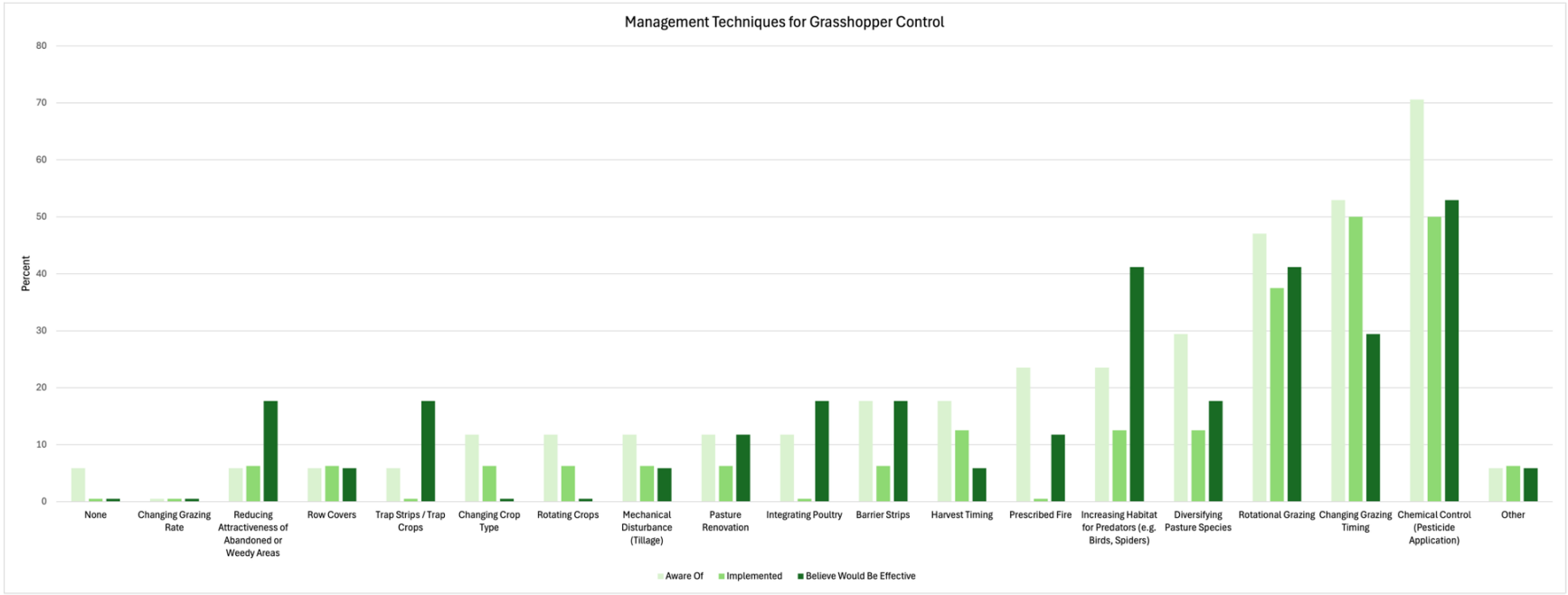



***Figure 4. Management techniques.*** *Results of survey respondents indicating their awareness of listed management techniques (n=17), whether they have previously implemented those techniques (n=16), and whether they believe those techniques would be effective (n=17).*

# *Producers View Outbreaks as a Community Problem Necessitating a Community-Based Solution*

## A Community Problem

Grasshoppers know no borders, rendering outbreaks, as one producer put it, a "community problem." Across interviews with producers, several noted that treatment efficacy depends on neighbors' participation: "The only way that the community collaborates would be…trying to get everyone on board, because otherwise…if it's a patchwork quilt then you create safe havens… and they'll just spread out from there, and you didn't do anything…so it's usually that mentality of all or none." "If you hit a certain part, you'd still have it elsewhere," remarked one producer, "which is why it was important to work with neighbors."

***"[I]f it's a patchwork quilt then you create safe havens…and they'll just spread out from there, and you didn't do anything, so it's usually that mentality of all or none."***

## Even Spraying Has Constraints

That all-or-none mentality plays out in what survey results revealed as the most dependable treatment: spraying pesticides. In areas with public lands, those public lands (and the agencies involved in managing them) are swept into the "community." Participation in APHIS' cost-sharing program depends upon establishing a 10,000-acre block of rangeland. One producer noted that "if you had smaller acreage, that's why we worked with neighbors to try to get up to that."

Across interviews with producers, several commented on the complexity of organizing a spray, which usually involves APHIS, the Bureau of Land Management (BLM), a potential "middle man," and the producers within the block. Producers emphasized that the presence of a "middle man," such as a producer-led organization or county extension, significantly helps streamline spray coordination—especially in the face of producers' busy schedules. One producer commented on the dissonance between APHIS and producers' communication methods: "email is their primary method of communication, and that's not a primary method of communication for producers…If extension hadn't stepped in to help with [coordinating sprays], there would have been a lot of gaps in information[.]" Even with that additional support, there was some evidence that garnering support for a spray is aided by a producer "wrangler": one producer who recognizes the potential need for a spray and spreads the word early on. For a spray to be effective, timing is everything. Producers noted that failing to assess interest or fill out "paperwork" early can serve as impediments to a successful spray.

And even with cost-sharing, spraying pesticide is a risk for producers, both expensive and uncertain. Producers noted instances in which prospective participants in a spray block would drop out: "more of us thought we were going to spray, and then there were people that dropped

off…we had kind of gotten a group of neighbors together that were going to do it, and then there weren't that many of us." One producer attributed this to uncertainty on sprays' efficacy: "even if we're doing large scale treatment operations, there's still large swaths of untreated land where those grasshoppers can move into treated areas in time." One producer noted that, "I think more of my fellow producers…they just didn't play, because they couldn't figure out how their costs could be justified" in the face of that uncertainty. Or put succinctly: "Sometimes doing nothing is the most cost-effective practice of all."

***"Sometimes doing nothing is the most cost-effective practice of all."***

Aside from difficulties organizing at the local level, producers also identified intra-agency constraints facing APHIS and BLM. Among those listed were budget constraints. The spray budget is allocated on a "first come, first serve" basis. Several producers commented on turnover, noticing when particularly knowledgeable personnel left an agency. Several also commented on sheer lack of personnel, particularly in local BLM offices: "BLM-wise, many areas are understaffed." One producer indicated that lack of BLM personnel contributed to underestimation of an area's problem and misidentification of grasshopper impact as grazing impact. "It was a little bit eye-opening…to realize that they didn't even know how much of an impact the grasshoppers had been. And also kind of concerning to think that they could have thought that it was a grazing impact versus grasshopper impact, because they were so out of touch." For similar reasons, some producers believe that outbreak extent may be generally underrepresented. The same producer indicated that APHIS was unaware about a grasshopper issue in the producer's area one year, which resulted in a slow response the following year. Another producer claimed it is difficult for any agency, but BLM in particular, to be able to adapt to local conditions when they have top-down mandates. Since public lands are leased by producers and neighbor producers' private lands, these constraints inherently become a "community problem." One producer noted that "APHIS…ties our local BLM's hands, pretty much…They have to rely on APHIS to come in, but when APHIS has all these other projects come in at the same time, certain areas get overlooked until it's too late." That impact trickles down to producers, forming "the biggest gripe that our landowners have": "they can't spray on BLM [land] when they want to because they have to have APHIS involved. They would like to, if they're going to spray themselves, spray on BLM [land concurrently], but they don't have that opportunity."

Across interviews with producers, many identified interpersonal relationships—between producers, between producers and agencies, and between generations—as further constraints. As one producer commented, "rural communities all have their own slightly different mentalities," quippily referring to them as "little cultures." One producer cited prior relationships between producers and agencies as an impediment to collaboration: "there's a variety of experiences…that don't necessarily have anything to do with grasshopper infestations, but do affect how willing they are to work." One producer also noticed a division between "old-timer" styles of ranching and newer ones, a "generational divide" of sorts.

## A Community Solution

Likely an artifact of its popularity, interviews with producers primarily focused on spraying pesticides. Regardless, community problems necessitate community solutions. The dynamics

described above would likely serve as common denominators in any management technique employed.

# *Scientific Uncertainty Around Grasshopper Behavior Remains*

## Sources of Information

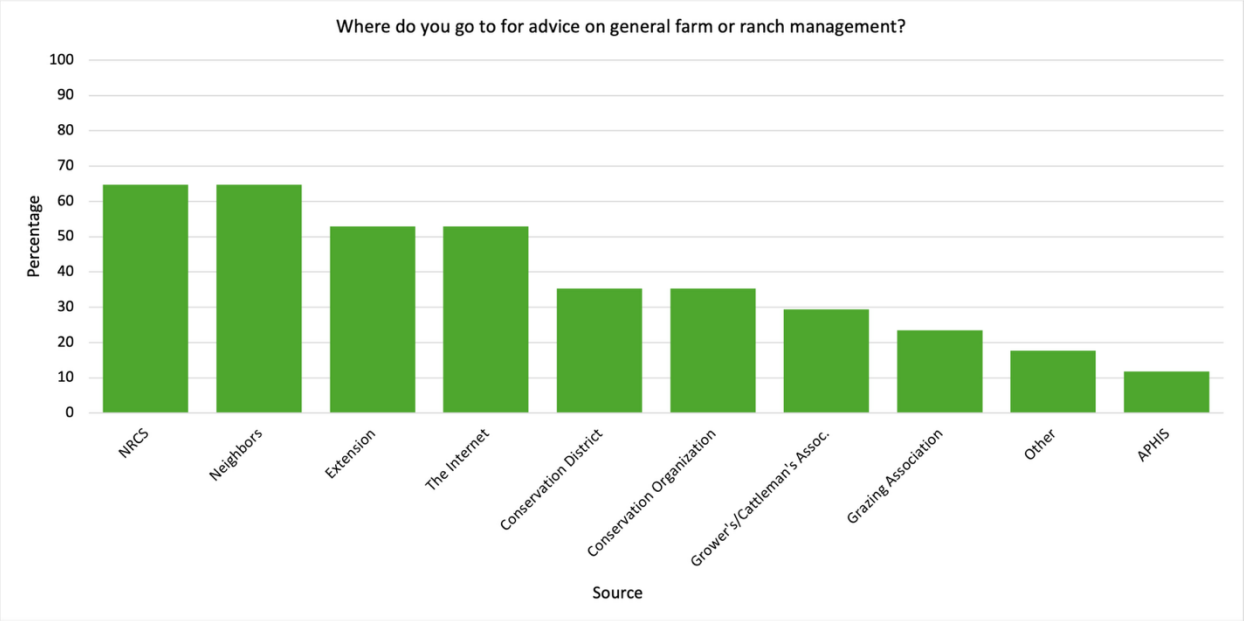



***Figure 5. Sources of information.*** *Results of survey respondents (n=17) answering "Where do you go to for advice on general farm or ranch management?"*

Of survey respondents selecting where they go for advice on general farm or ranch management, the most prominent sources of information were neighbors and the Natural Resources Conservation Service (NRCS), at 65% of respondents each (Fig. 5). Trailing those sources were the internet and extension services, at 52%. Grower's and cattleman's associations, conservation districts, and conservation organizations featured less prominently, identified by less than 50% of respondents. Of producers selecting "other," other sources identified included agriculture events and "one particular university professor."

When asked who they consult, collaborate with, and trust regarding grasshopper management, specifically, producers primarily cited APHIS as their first point of contact. Most producers regarded APHIS highly (including remarks like "they did a really great job of doing what they could under the circumstances," "worked very flexibly with people," and that one agent was "truly a public servant at the highest level"). Across interviews, it seemed that most producers generally respect state-level APHIS staff, attributing any difficulties to systemic problems.[4]

[4] Note that this statement refers to state staff specifically and not APHIS as a broader federal agency.

Many producers expressed that coordinating a response often begins with conversations amongst neighbors, by "email chain," for example, and typically involves convening several of the survey-listed groups (otherwise consulted for general farm and ranch management) in one room.

One producer cited the "divide between universities and agricultural producers" as an impediment to sharing both old and new information about management techniques, a "natural divide where the universities will do this research…all this work, and then it's almost like putting a bottle or a book on a shelf, and it's just not touched." The producer also noted limited access to peer-reviewed journals, which is where universities typically publish their findings.

## Scientific Uncertainty

Most producers, however, expressed that even if they had access to peer-reviewed journals, there would not be much to find. When asked whether their knowledge of how grasshoppers behave and migrate has grown over time, producers responded similarly: "oh, no," "no, probably not [over twenty years]," "yeah it has, though I would say that it's still quite a puzzle to me," "in a very slow capacity, it has expanded," "yes and no," "it's kind of went from zero to one of understanding," and "the body of knowledge is stagnant." One producer quipped: "Yes, grown very much. So now I'm up to knowing 10% of what I need to know." In reference to the literature, one producer noted that "they might have put it out new that year, but it was the same exact information that was shared, probably 10 years ago."

***"Yes, grown very much. So now I'm up to knowing 10% of what I need to know."***

When asked whether there are patterns or signs that indicate a possible outbreak, producers' responses were variable. One producer who consistently experiences significant impacts boiled it down to three controlling factors: (1) weather – hot, dry, (2) soil type – "silty is best", and (3) vegetative cover – "bare ground best." Regarding interactions between the factors, the producer observed that "if soil type and weather are against you long enough, your vegetative cover will not bail you out."[5] Other producers expressed similar hunches, commonly citing "drought," but noted significant uncertainty. One stated that "it's one of those unknowns, which also, I think, makes it difficult to come up with some kind of specific public program." Another producer stated, "there's nothing I can kind of hang my hat on that predicts why some years are worse than others." Two producers separately referred to potential patterns or signs as mere "wives' tales." This lack of understanding trickles into APHIS' predictions: "One of those years, the grasshopper outbreak maps did predict it would be bad for us. The next time it did not."

***"There's nothing I can kind of hang my hat on that predicts why some years are worse than others."***

That same uncertainty persists regarding the efficacy of alternative management techniques, which two producers separately referred to as "anecdotal." Regarding grazing, one stated that

[5] The same producer remarked that the National Oceanic and Atmospheric Administration (NOAA)'s "weather forecasting is getting much, much worse," with "no accuracy in 30 day or longer forecasts," limiting weather's usefulness as a factor.

"You know, there's a lot of folks out there saying, well, manage your grazing properly, and yep, they attacked the neighbor's place, but not our place, and then someone else is like, well, yeah, but I was using all those methods, but they still came after my place." Regarding maintenance of a healthy grassland, one clarified that "it's more anecdotal than…really credible scientific documentation. I haven't been convinced that a healthy grassland in and of itself prevents hoppers from showing up." The same producer expressed doubt about maintaining a healthy grassland's dominance in the face of other uncontrollable factors like moisture level. Another producer echoed that sentiment, arguing that "grazing has a role, but it's not a magic bullet" when confronted with *force majeure* like weather and soil type. They also identified other impediments: some alternatives might work, but only in wetter areas, and "biological control probably holds a lot of promise, okay, but nobody's gonna get rich figuring that out."

Besides scientific uncertainty, implementation of alternatives could be undermined by the relationship between producers and environmental groups. One producer noted that it is difficult to get environmental groups to "sit down and visit with producers." Another remarked that "The attitude is usually 'You're an outsider, so how are you supposed to know what the [expletive] is best for this landscape?'" Another thought that environmental groups "based a long ways from here" "aren't interested in trying to do biological controls, you know." This last comment would suggest that some producers believe that environmental groups may be putting funds towards combatting pesticide application rather than investing in research on alternatives that would mitigate producers' risk. As one producer put it, producers "don't want to spend any more money than necessary, unless they really know they're going to get a measurable result."

An informal systems diagram illustrating these observed relationships is located in Appendix B.

# CONCLUSION

The main takeaways from our investigation into producer responses to grasshopper outbreaks were as follows:

- Most producers consider grasshoppers a serious threat to livestock operations, causing increased economic stress.
- Producers are implementing many management responses to grasshopper outbreaks, but pesticides remain the most implemented and perceived to be effective.
- Producers see outbreaks as a community problem necessitating coordination amongst community members to be effective.
- Scientific uncertainty remains around grasshopper behavior and conditions for outbreaks, making proactive management and coordination difficult.

As noted in our introduction and methods, this report is not meant to be exhaustive. The small sample size means that conclusions from this report should be interpreted within the scope of the survey and interviews conducted. We hope ideas from this pilot study spark further research.

# WORKS CITED


APHIS. Rangeland grasshopper and Mormon cricket suppression program final environmental impact statement. 2019;1–135. https://www.aphis.usda.gov/sites/default/files/rangeland-grasshopper-mormon-cricket-program-final-eis.pdf

Belovsky GE, Slade JB. Insect herbivory accelerates nutrient cycling and increases plant production. Proceedings of the National Academy of Sciences of the United States of America. 2000;97:14412–14417. https://www.pnas.org/doi/10.1073/pnas.250483797?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed

Branson DH, Joern A, Sword G. Sustainable Management of Insect Herbivores in Grassland Ecosystems: New Perspectives in Grasshopper Control. BioScience. 2006;56(9):743–755. https://doi.org/10.1641/0006-3568(2006)56[743:SMOIHI]2.0.CO;2

Joern, A. Disturbance by Fire Frequency and Bison Grazing Modulate Grasshopper Assemblages in Tallgrass Prairie. Ecology. 2005;86(4):861–873. http://www.jstor.org/stable/3450840

Joern, A. Variation in Grasshopper (Acrididae) Densities in Response to Fire Frequency and Bison Grazing in Tallgrass Prairie. Environmental Entomology. 2004;33(6):1617–1625. https://doi.org/10.1603/0046-225X-33.6.1617

Kistner-Thomas E, Kumar S, Jech L, Woller DA, Modeling Rangeland Grasshopper (Orthoptera: Acrididae) Population Density Using a Landscape-Level Predictive Mapping Approach. Journal of Economic Entomology. 2021;114(4):1557–1567. https://doi.org/10.1093/jee/toab119

Lockwood, J. Locust: The Devastating Rise and Mysterious Disappearance of the Insect that Shaped the American Frontier. Basic Books; 2004.

Montana State University. Grasshopper Management and Control in Montana. Last visited June 21, 2026. https://www.montana.edu/extension/lila_extn/winter_spring_2022/grasshoppermanagementandcontrol.html

Onsager, JA. Suppression of Grasshoppers in the Great Plains through Grazing Management. Journal of Range Management. 2000;53(6):592–602. https://doi.org/10.2307/4003152

Plant Protection Act, 7 U.S.C. § 7717.

Porter EE, Redak RA. Short-term recovery of the grasshopper communities (Orthoptera: Acrididae) of a California native grassland after prescribed burning. Environmental Entomology. 1996;25:987–992. https://doi.org/10.1093/ee/25.5.987

Rodbell EA, Kaur N, Schell S, Short-horned grasshopper (Orthoptera: Acrididae) ecology and management in the Western United States. Journal of Integrated Pest Management. 2025;16(1):33. https://doi.org/10.1093/jipm/pmaf030

Vermeire LT, Mitchell RB, Fuhlendorf SD, Wester DB. Selective control of rangeland grasshoppers with prescribed fire. Journal of Range Management. 2004;57:29–33. https://www.ars.usda.gov/arsuserfiles/30300000/Publications/hoppercontrol04.pdf

Wan, NF et al. Pesticides have negative effects on non-target organisms. Nature Communications. 2025;16:1360. https://doi.org/10.1038/s41467-025-56732-x

Xerces Society for Invertebrate Conservation v. Shea, No. 3:22-cv-00790-HZ, 2024 LX 133574, at *1–2 (D. Or. Aug. 1, 2024).

# APPENDIX A

Yale University

## Background

You are invited to take this survey as part of a research study on **farmer/rancher experiences with and responses to grasshopper and/or Mormon cricket outbreaks** in eastern Oregon and central/eastern Montana. Information collected in this study will help researchers better understand outbreak severity/impacts and the motivations behind land manager decision-making.

This research is being conducted by Yale Master's students Jack Newman and Alexia Zolenski. Survey responses will supplement in-person or remote conversations with land managers. If you would be willing to participate in a follow-up conversation, please indicate so and provide your contact information at the end of this survey.

The results of this research study may be presented at professional meetings and/or published in journals or a summary report, **but will not include any identifying information**.

**Thank you** in advance for taking this survey, which **should take no longer than 10 minutes**. Text box responses are intended to be short, though you may share as much as you please.

Where is the location of your farm/ranch?

- ○ Central/Eastern Oregon
- ○ Central/Eastern Montana

What is the approximate size of your ranch (in acres) inclusive of any public land leases?

- ○ < 500
- ○ 500-1000

- ○ 1,000-10,000
- ○ 10,000-25,0000
- ○ > 25,000
- ○ Prefer not to Answer

Does your operation include:

- ○ Livestock
- ○ Crops
- ○ Both

Do you have a public lands lease for grazing?

- ○ Yes
- ○ No

Has your farm/ranch been affected by a grasshopper and/or Mormon cricket outbreak?

- ○ Yes
- ○ No
- ○ No, but I know others who have.

## Responses & Management

How would you rank grasshoppers and/or Mormon crickets as a threat to your operation?

Not a Threat — Greatest Threat

0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10 ○

Have you had to change anything about your operation as a result of an outbreak?

○ [ ] Yes - if so, please explain:

○ No

What management techniques are you aware of for avoiding or controlling grasshopper and/or Mormon cricket outbreaks? Please select all applicable choices.

- ☐ changing crop type
- ☐ rotating crops
- ☐ mechanical disturbance (tillage)
- ☐ chemical control (pesticide application)
- ☐ rotational grazing
- ☐ prescribed fire
- ☐ pasture renovation

- [ ] diversifying pasture species
- [ ] changing timing of seeding
- [ ] changing density of seeding
- [ ] trap strips or trap crops
- [ ] barrier strips
- [ ] reducing attractiveness of abandoned or weedy areas
- [ ] harvest timing
- [ ] row covers
- [ ] integrating poultry
- [ ] increasing habitat for predators (birds and spiders)
- [ ] changing grazing timing
- [ ] changing stocking rate
- [ ] none
- [ ] _____ other

Which management techniques have you implemented? Please select all applicable choices.

- [ ] changing crop type
- [ ] rotating crops
- [ ] mechanical disturbance (tillage)
- [ ] chemical control (pesticide application)
- [ ] rotational grazing
- [ ] prescribed fire
- [ ] pasture renovation
- [ ] diversifying pasture species
- [ ] changing timing of seeding

- [ ] changing density of seeding
- [ ] trap strips or trap crops
- [ ] barrier strips
- [ ] reducing attractiveness of abandoned or weedy areas
- [ ] harvest timing
- [ ] row covers
- [ ] integrating poultry
- [ ] increasing habitat for predators (birds and spiders)
- [ ] changing grazing timing
- [ ] changing stocking rate
- [ ] none
- [ ] other

Which management techniques do you believe would be the most effective? Please select all applicable choices.

- [ ] changing crop type
- [ ] rotating crops
- [ ] mechanical disturbance (tillage)
- [ ] chemical control (pesticide application)
- [ ] rotational grazing
- [ ] prescribed fire
- [ ] pasture renovation
- [ ] diversifying pasture species
- [ ] changing timing of seeding
- [ ] changing density of seeding
- [ ] trap strips or trap crops

- [ ] barrier strips
- [ ] reducing attractiveness of abandoned or weedy areas
- [ ] harvest timing
- [ ] row covers
- [ ] integrating poultry
- [ ] increasing habitat for predators (birds and spiders)
- [ ] changing grazing timing
- [ ] changing stocking rate
- [ ] none
- [ ] other

Have you participated in a federal (APHIS) spraying/control program?

- ○ Yes (including private land or public land leases)
- ○ No

Please describe your primary motivation in selecting a particular management technique (for example, costs, environmental impact, recommendations of others)?

Where do you go to for advice on general farm or ranch management? Please select all applicable choices.

- [ ] APHIS
- [ ] NRCS
- [ ] extension
- [ ] conservation district
- [ ] grazing association
- [ ] grower's or cattleman's associations
- [ ] conservation organization
- [ ] neighbors
- [ ] the internet
- [ ] other

## Follow-Up

Is there anything else you wish to share with us about this topic?

We would love to have a follow-up conversation with you! Are

you willing to participate in a follow-up conversation?

- ○ Yes - if so, please include your preferred contact method (phone or email):
- ○ No

# SEMI-STRUCTURED INTERVIEW GUIDE

**Title:** *Investigating Ranchers' Intervention Strategies for Grasshopper and/or Mormon Cricket Suppression on Western Rangelands*

**Purpose:** To explore how individuals experience, interpret, and respond to grasshopper and/or Mormon cricket aggregations, and how these interpretations shape pest management practices, ecological knowledge, and cultural values.

## Interview Details

| Field | Response |
|---|---|
| 1. Interviewer Name | _____ |
| 2. Participant ID# | _____ |
| 3. Interview Date (dd/mm/yyyy) | ___ / ___ / _____ |
| 4. Participant agrees to the interview to be digitally recorded | ☐ Yes ☐ No |
| 5. Participant consents to having personally identifiable information attached to their interview statements | ☐ Yes ☐ No |
| 6. Time Interview Began (hhmm - 24hr clock) | _____ |
| 7. Time Interview Ended (hhmm - 24hr clock) | _____ |

## ❖ Introduction (To be read aloud at the start of each interview)

"Thank you for agreeing to participate. I'm conducting research on grasshopper and/or Mormon cricket outbreaks and how they are experienced and managed by communities and agencies in the West. This is a voluntary interview. You may decline to answer any question or stop the interview at any time. With your permission, I'd like to record our conversation so I can focus on listening."

## I. Background & Role

1. Can you tell me a little about your role and your work as it relates to land management or agriculture in this region?

    a. Describe the location of your operation (general topographic/climate, etc.).
    b. Describe the type of operation (crops, rangeland).
    c. Can you explain your grazing strategy (stocking rate, rotation, irrigation)?
    d. Do you have a public lands lease for grazing?

2. Have you personally encountered a grasshopper and/or Mormon cricket outbreak(s)? If so, can you describe that experience?

## II. Responses & Management

3. How do you or your operation typically respond to or prepare for grasshopper and/or Mormon cricket outbreaks? What is your biggest concern?

    a. What management methods do you use for the outbreak? Why?

    b. What impacts have you experienced in your agriculture operations? Why?

4. What methods are you aware of for managing grasshopper and/or Mormon cricket outbreaks? What methods are most common in this region?

5. What do you think are the most effective or ineffective methods of those?

6. Do you consult/collaborate with others on grasshopper and/or Mormon cricket interventions (e.g., federal agencies, Tribal governments, scientists, your crop or cattle association)? If so, who? Are there sources that you trust more than others?

7. What are the dynamics between groups or agencies about how to handle outbreaks?

8. One of these agencies, APHIS, has a suggested amount of grasshoppers per square yard at which not taking action would cause economic damage. What is *your* threshold for initiating management activities, and what is the driving force behind it?”

## III. Knowledge & Monitoring

9. Has your knowledge of how grasshoppers and/or Mormon crickets behave or migrate grown over time? If so, can you tell me more about it?

10. Are there patterns or signs you or your community recognize that signal a possible outbreak?

## IV. Values, Ethics, and Motivations

11. What is your opinion on grasshoppers and/or Mormon crickets?

a. Are they a threat, a nuisance, a natural part of the ecosystem, or something else?

12. Have your attitudes about grasshoppers and/or Mormon crickets changed over time?

13. Do you see any tension between conservation and pest control efforts?

## VII. Wrap-Up

14. Is there anything I haven't asked about that you think is important for me to understand?

15. Are there others you'd recommend I speak to?

"That's the end of the questions that I have for you today. Do you have any final thoughts or questions you'd like to ask about this study?

I want to sincerely thank you for your time and for the helpful information that you provided."

# APPENDIX B

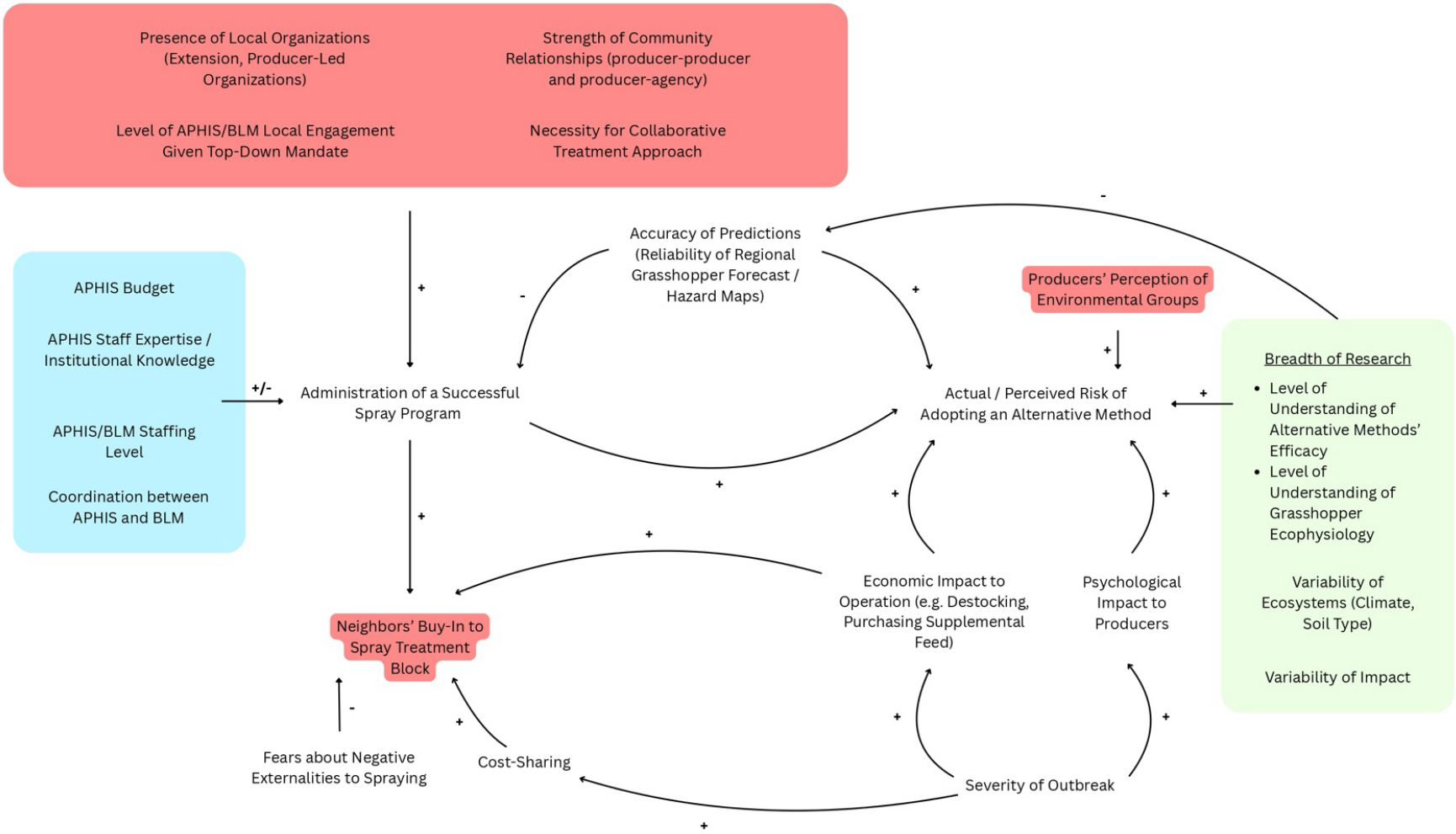



***Figure 6. Informal systems diagram of relationships observed in survey responses and interviews with producers.*** *This diagram is limited to the universe of this study and should not be taken as all-inclusive. A "+" indicates that from has a positive effect on to, and a "-" indicates that from has a negative effect on to. While most relationships could have a "+" or "-" depending on circumstance, they are assigned here to represent relationships as observed in this study (e.g. limited breadth of research was observed to have a positive effect on actual/perceived risk of adopting an alternative method in this study, though that could change if research becomes less limited in the future). Elements highlighted red involve social aspects, blue involve intra-agency dynamics; and green involve uncertainty.*