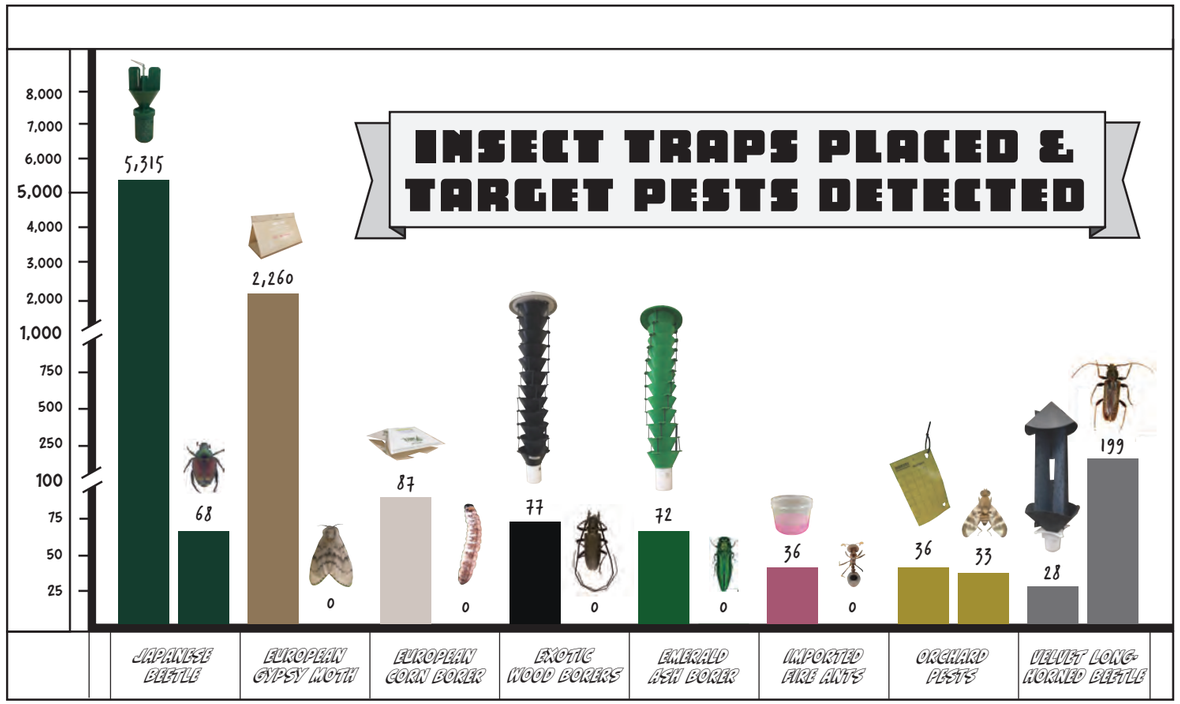
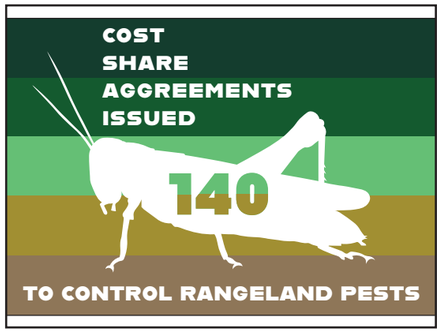
2021 Insect Report

Utah Department of Agriculture & Food
Division of Plant Industry
February 2022

Japanese Beetle
Popillia japonica (Newman)

At a Glance Accomplishments





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MESSAGE FROM THE MANAGER

It is an honor to serve as the Utah Department of Agriculture and Food's (UDAF) State Entomologist. Born and raised in Utah, I take great pride in our beautiful state, and I am rewarded every day by the people, places, and industries I have the opportunity to serve.

As I look back at being a UDAF employee over the past 20 years, I marvel at how far we have come and how well we have adapted to the constant challenges and changes we face. The responsibility of protecting Utah's agriculture and natural resources from invasive pests and diseases is not easy. This past year presented many challenges for agriculture, including our insect and pest programs. We dealt with the worst drought on record, along with employment, and supply shortages. The challenges we overcame made our program resilient and allowed us to maintain our important role in securing the food supply, while protecting our natural resources from harmful agricultural pests. While UDAF celebrated turning 100 years old last year, it should come as no surprise that Utah has an even longer history managing pests prior to statehood. Early settlers recognized the importance of protecting our food supply from pests and disease. From rangeland pest infestations during Utah's early history to successful eradication efforts of invasive species that helped build our program and set a precedent for the future. Through these challenges, we strive to provide services that help industry keep on task, by mitigating harmful quarantined pests and facilitating the export of Utah agriculture commodities.

Our reputation of success began with the early eradication of gypsy moth, and the more recent eradication of Japanese beetle in 2014. These two pests remain high on our priority list and are the two largest insect trapping programs in the state. When others give in to invasive pest introductions and establishments, it makes our job even more difficult as we strive to protect the things we love here in Utah. However, our department has proven that with diligence, hard work, and support from our stakeholders, we can overcome pest introductions by not doing the easy thing, but the right thing for our country and state.

In spring of 2021, the department implemented a new quarantine program to reduce the risk of emerald ash borer (EAB) spreading to Utah's urban and natural landscapes. This quarantine went in effect shortly after the United States Department of Agriculture (USDA) rescinded their EAB quarantine, which ended federal regulation of the pest. EAB has killed tens of millions of trees where it has become established, but fortunately, to date, EAB has not been detected in Utah. UDAF believes in early detection, rapid response, suppression, and eradication (whenever possible) of invasive pests. We hope to prevent the introduction of EAB entirely and are optimistic that the new quarantine protocol will provide the time needed for stakeholders to diversify urban forest species, promote the use of local firewood and plan for replacements and removals before we find this pest attacking *Fraxinus* spp. within the state.

Rangeland insect pests also continues to impact farmers and ranchers in portions of the state. While the populations are nowhere near historic highs due to low forage and little opportunity to water, even low populations appear to be causing severe hardships for our producers. With the worst drought ever recorded and a future unknown, I can reassure you that the department is here to support and assist all Utah producers pull through these challenging times.

I would like to express gratitude to our UDAF Apiary Program team, and the great work that has taken place to mitigate the spread of pests and diseases to native and managed pollinators. It pays dividends when a group of state and county inspectors are engaged, committed, and support the important tasks of protecting the apiary industry and helping sustain our pollinators. With their help we will continue to successfully mitigate the spread of American foulbrood, new apiary pest introductions and provide apiary services in the beehive state.

My sincere appreciation goes to the great staff I have the fortunate opportunity to work with. Our success is because of their efforts, ambition, and willingness as public servants, often going above and beyond what is expected of them. Even with less staff and resources than anticipated, we were able to place a record number of monitoring and detection traps across the state. The UDAF Insect Program has become more efficacious and resilient because of our full-time and seasonal staff. This dedication does not go unrecognized, and it is because of your efforts that our monitoring and detection program is the success it is today.

Last but certainly not least, and with deep respect, I would like to thank all stakeholders and partners that continue to support our programs. It is only with your assistance that we will be able to overcome the challenges we face against invasive plant pests and disease in the years to come. We are thankful for your ongoing support of our trapping, mitigation, and eradication efforts. You are our eyes and ears. It is in your successes and maintaining our natural resources where we find our reward, knowing we help to support you and protect agriculture in our beautiful state.

In this report we hope you find value in the UDAF Insect Program and what we have accomplished together over the past year. We may be few in number, but the passion, dedication and love for our great state and its people is what makes our program something we can all be proud of. Thank you!

Respectfully,

Kristopher Watson
State Entomologist

News & Notes

Regulations Update

Emerald Ash Borer Quarantine Enacted

With unanimous approval from the state's Agricultural Advisory Board, the Utah Department of Agriculture and Food (UDAF) enacted a quarantine relating to emerald ash borer *Agrilus planipennis* (Fairmaire), the invasive wood boring ash *Fraxinus* pest. The quarantine regulates the importation of ash nursery stock, ash firewood, and other articles that vector EAB; it went into effect in June of 2021. The state enacted the rule as a result of the United States Department of Agriculture (USDA) Animal Plant Health Inspection Service's (APHIS) deregulation of emerald ash borer in January, 2021. Utah joins California and Montana in enacting a state quarantine for this pest.

Utah and many other Western states have managed to stay free of EAB since it was first detected in the United States (U.S.) in 2002. The previous federal quarantine protected uninfested areas of the country by prohibiting the movement of ash nursery stock and firewood from areas known to be infested with the pest; it was instrumental in keeping states like Utah EAB-free. However, with the federal deregulation being completed, the only way to prevent infested articles from entering Utah was to enact new state rules.

Support for a state quarantine started in 2017, when USDA APHIS announced their intention to remove their EAB regulations within a few years. The Utah Emerald Ash Borer Task Force, which comprises representatives from city forestry services, community groups, universities, and local governments, urged UDAF to protect Utah's urban and native ash inventory. The enactment of these new state quarantine rules was the culmination of strong encouragement by these various stakeholders that would be negatively impacted by EAB if it were to be introduced. For more information, see the Exotic Wood Borer section on page 34 or see Utah Administrative Code R68-11, for the full text of the quarantine rules.

Personnel Changes

UDAF Insect Program

Jenna Crowder at the Utah Honey Harvest Festival in Grantsville

Jenna Crowder is a new face in the Insect Program and a new Utahn who joined UDAF in May of 2021 as a Diagnostic Entomologist. As an insect enthusiast with a strong ethic of public service, Jenna works with Utah's beekeepers to diagnose, treat, and regulate honey bee maladies.

While interning at a honey bee research facility in 2016, Jenna fell in love with insects and has since steadfastly followed her passion for the 6-legged beasts. Before coming to UDAF, she had previously worked in the North Carolina Museum of Natural Sciences Arthropod Zoo, the Clemson University Arthropod Collection, and the Caterino Arthropod Biodiversity Lab.

Jenna holds a Bachelor's of Science in biology from Clemson University, where her curated curriculum focused heavily on entomology. Honey bees are her primary domain, but she is competent in many other arthopod-related subject matters. She is an awarded educator and was formally recognized by the Clemson University graduate school for her teaching excellence in 2020. She brings this same meticulous sense of curiosity and professional stewardship to her roles in the UDAF Apiary Program and Entomology Lab.

State and County Cooperative Apiary Program

The Utah State and County Cooperative Apiary Program is pleased to welcome two new inspectors to the team in 2021. Rex Weston is the new inspector for Weber County. Rex replaced Brock Lennox whom he met through beekeeping five years before Brock's passing in 2020. Rex currently has three apiaries. Having worked through many problems as a beekeeper and enjoyed many successes, Rex is now directing his attention to the problems facing Weber County's beekeepers. He focuses on all bee maladies, but most intently on the control of the Varroa mite that causes so much damage locally. For Rex, reaching out to educate newer beekeepers is a high priority.

Dean Hannibal also joined the program and, beginning in the 2022 field season, will be performing apiary inspections throughout Summit and Wasatch counties, as a state-contracted inspector. Dean's interest in beekeeping began in 2010, starting with a single package and hive. He now attends to four apiaries along the Wasatch back in the towns of Francis, Oakley and Hoytsville. He continues to be amazed by the complexity of honey bees and enjoys meeting those who keep them.

Both Casey Lofthouse and John Scott retired from the Apiary Program in late 2021, leaving vacancies in Washington and Sanpete counties respectively. UDAF is grateful to both Casey and John for the hard work they committed to the cooperative Apiary Program and wishes them both great success in their future endeavors. The department is currently working to identify potential replacements for these two inspectors.

MOVING DELAYED!

UDAF's move from the William Spry Agriculture Building to the new Taylorsville State Office Building (TSOB) did not occur in 2021. UDAF plans to move into TSOB in the spring of 2022. For more information see the Entomology Lab section (page 24).

Legistlative Update

HB224: Pollinator Pilot Program

In response to a funding bill passed by the Utah Legislature, H.B. 224 Pollinator Amendments, UDAF has teamed up with Southern Utah University, the University of Utah Extension Service, and Utah Division of Wildlife Resources to create a Pollinator Pilot Program focused on providing pollinator education and resources for the general public. This program will identify native plant species that are suitable for planting in targeted ecoregions within Utah and provide funding assistance to interested individuals for the purpose of pollinator habitat restoration. The UDAF Apiary Program looks forward to providing informational and administrative assistance as this endeavor moves forward into 2022.

Invasive Pest Detected

Lanternfly found at shipping yard

Spotted lanternfly, *Lycorma delicatula* (White), is a pest that has been making headlines as it rapidly spreads to more areas of the continent. First discovered in the U.S. in 2014, it has already established populations in 11 states as of 2021. This destructive pest is native to China and has a large host range of grapes, fruit trees, willow, pine, and several other broadleaf trees. In addition to the damage it can cause to plants by feeding, the spotted lanternfly creates an abundance of honeydew that leads to significant mold issues for affected trees and vines. USDA APHIS considers most states to be at risk for the establishment of the spotted lanternfly. Due to its charismatic looks, spotted lanternfly is easy to recognize and report. In October, a single, dead spotted lanternfly was found at a Salt Lake County shipping facility. However, no subsequent specimens have been found at the facility or anywhere else in Utah. UDAF asks anyone that believes they have found a spotted lanternfly to either collect a specimen or take a photo and contact the Insect Program.

Spotted Lanternfly

Meet an Insect Trapper

1) How did you become an Insect Trapper?

Many of my colleagues at the ski resort where I instruct are trappers and I heard lots of good things about the position. As they described the work, I became increasingly interested in experiencing it for myself. It seemed an excellent fit for my winter seasonal work and the outdoor, independent nature of the job itself was appealing. Finally, circumstances aligned to free me up to join the crew.

2) Do you have a favorite insect?

Well, I like the emerald ash borer because it has the good manners to stay out of Utah.

I could say I have a strong connection to the Japanese beetle (JB), but mostly as a pairing of an indispensable adversary. Seeking its detection and eradication gives me a focus and the trapping team a unifying purpose. Without the JB…what would we do all summer? I do admire its tenacity and resourcefulness, though. It's quite pretty, too.

3) Tell us about your most memorable day on the job.

I guess there's memorable good and memorable bad. One of the most memorable/challenging days was during the dry hurricane of Sept. 2020. Temps dropping 50 degrees, winds approaching 100 mph, power lines and trees dropping all around us... Yikes!

Memorable/good days…too many to list. Some days the light, temps, and location/views all just come together for a splendid bit of time.

Also pleasant are the days when a homeowner is kind to thank us for our efforts to keep the critters at bay. It helps to remind me of our purpose.

4) If you could sum up your work into one word, what would it be?

Freedom

5) The soapbox is yours! Anything else you want to tell the world?

I toyed with going into some form of natural resources work way back in the mid-70s, in high school. Life went another way, so I'm really thrilled to now be able to complete that idea. I love that I can make a difference in the quality of the local environment, and have a job that gives me a huge amount of variety and flexibility. Purpose and autonomy.

As well, I have been able to see parts of the Wasatch Front I never would have any other way. I've probably driven nearly every road between Ogden and Santaquin, from the Lake shore to the Wasatch Back, and tromped in most of the yards, businesses and parks along the way.

Alan Lindsay has been a seasonal Insect Trapper since 2018. In addition to being one of the most efficient trappers to have done the job, he has helped with everything from developing new trap deployment methods to consulting on organizational improvements (he has a graduate level degree in the subject matter). Alan is a highly valued member of the team because of his expertise in so many areas and his willingness to apply his knowledge to the job.

Alan Lindsay

Alan pictured above with a model of his recently envisioned method of setting emerald ash borer traps.

In 1892, before Utah was even a state, the territorial legislature heeded the requests of pioneer beekeepers and created the foundation of the Utah Apiary Program. At its core, the program gave counties power to appoint bee inspectors who identified and mitigated contagious honey bee maladies. That core purpose is still in effect today, over a century later. As of 2021, there are eight county bee inspectors and two state-wide bee inspectors that cooperatively work to serve Utah's beekeepers by diagnosing and suppressing an ever-increasing variety of *Apis mellifera* (Linnaeus) pests, parasites, and diseases. This collaborative work protects the approximately 31,000 honey bee colonies that call Utah home and supports an industry valued at $1.2 million in honey production and $6.57 million in almond pollination services.

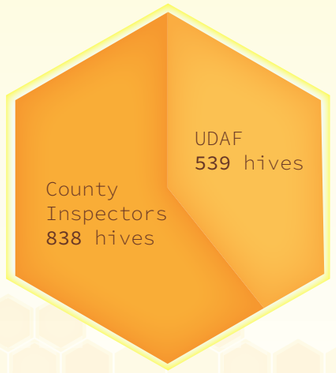


Figure 1. Number of hives inspected by UDAF state inspectors and county inspectors.

Inspection Results

There was much work to report in 2021 from the State and County Cooperative Apiary Program. State inspectors visited 128 operations and inspected 539 individual hives. County officials inspected another 201 operations and 838 hives (Figure 1).

Varroa mite *Varroa destructor* (Anderson and Trueman), the most devastating honey bee pest, and a condition associated with this parasite known as parasitic mite syndrome (PMS) continued to be prolific throughout the state, with 5.0% of inspected hives showing symptoms of the syndrome. In the lead up to the parasite's seasonal population peak phase, the UDAF Apiary Program sent a newly re-designed postcard (Box 1) to all registered beekeepers urging that they take suppression measures during this critical time frame. Data collected indicates this effort facilitated coordinated control success early on, however there was a late season resurgence of the parasite and its associated problems. In 2022, the program will continue to emphasize in communication with beekeepers that vigilant monitoring is crucial to controlling the pest, especially during the late-season months, and that multiple chemical applications may be required to fully control parasitic infestations.

American foulbrood (AFB) *Paenibacillus larvae*, the most deadly and contagious of brood (larvae) diseases, was found in 1.4% of hives inspected, which is a slight decrease from last year, and a significant decrease from 2018's decades-long high of 3.9% AFB occurrence. The UDAF Apiary Program's goal is to keep this disease's incidence below 1% of colonies – and this year's 1.4% occurrence rate is remarkably close to reaching that goal. The reduction in AFB occurrence since 2018 indicates the effectiveness of the Apiary Program's actions in response to AFB detections and outreach to beekeepers regarding antibiotic procurement.

European foulbrood (EFB) *Melissococcus plutonius* disease was found in 2.6% of hives, which is a decrease from last year (3.6%). EFB is a less serious brood disease than AFB, but it can still harm overall colony health if left unchecked.

The fungal brood pathogen chalkbrood (CB) *Ascophaera apis* was found in 1.9% of hives inspected. Like EFB it is considered a less problematic malady than AFB, but persistent infections can contribute to colony losses.

Despite a small population boom of the invasive bee pest small hive beetle (SHB) *Aethina tumida* (Murray) from 2016 to 2019, there were no detections of SHB in 2021. This finding is similar to last year, when no SHB were detected in the state. The pest has previously been confirmed in Davis, Millard, and Washington counties. Utah's dry climate is thought to be unaccommodating to SHB, which may explain why it has not been found since 2020.

BOX 1: Varroa Postcard Re-design

In response to increasing Varroa mite infestations, the Apiary Program designed a fresh outreach postcard for 2021. With clean lines and a focus on iconography, this new design avoids wordy walls of text and is in line with UDAF's comprehensive style guide and overall brand. The postcard was mailed out to every registered Utah beekeeper in late July, arriving in their mailboxes right before peak Varroa season. Beekeepers were presented with a clear message about effective Varroa control – measure, treat, and repeat! The result of this effort was a decrease in observed Varroa mite infestations during August and September as compared to previous years. However, October continued to be associated with an abundance of highly parasitized hives. Outreach efforts in 2022 will stress the importance of consistant Varroa monitoring after the first mite treatment and the potential need for multiple mite treatments.

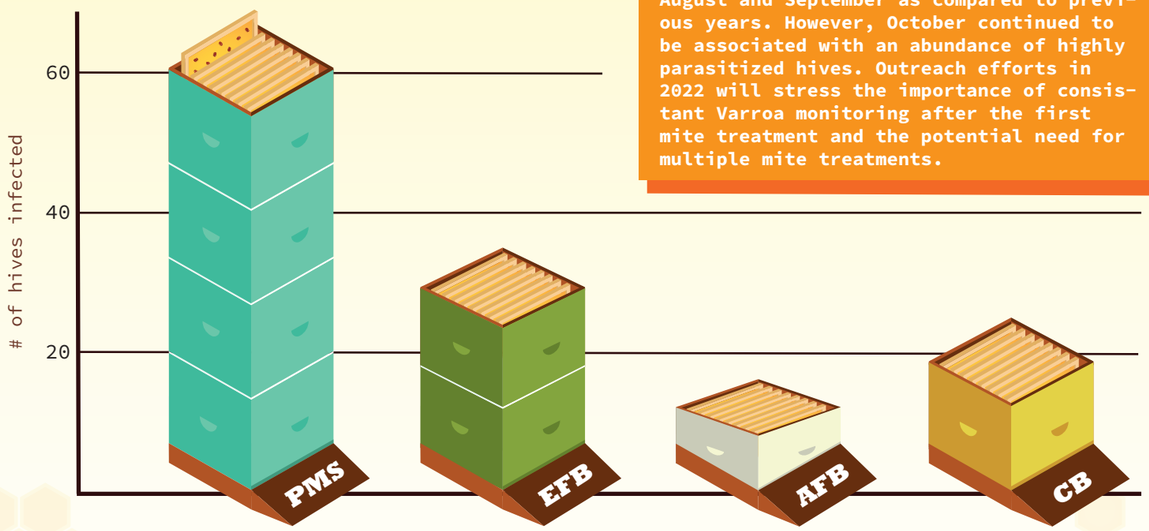


Figure 2. Number of hives found to be afflicted with significant honey bee maladies in 2021. PMS and CB were identified during inspections. EFB and AFB diagnoses were confirmed by the UDAF Entomology Lab.

The National Honey Bee Survey

The United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) began the National Honey Bee Survey (NHBS) in 2009 to monitor and address nation-wide honey bee health problems. This survey takes an epidemiological approach to document honey bee diseases, pests, and pathogens. Additionally, NHBS monitors for invasive threats to honey bees, including the parasitic mite *Tropilaelaps clareae* (Delfinado and Baker), the Asian honey bee *Apis cerana* (Fabricius), and pesticide residues in secondary hive products (such as pollen and beeswax). Since 2011, the UDAF Apiary Program and beekeepers throughout the state have participated in NHBS and have contributed hundreds of samples to this continually growing body of scientific knowledge.

This federally-funded program allocates funds and specialized supplies to each participating state to cover the costs of labor and ensure the quality of collected samples. Sampling involves collection of adult bees (Figure 3), immature bees (Figure 4), and pollen samples (Figure 5) from apiaries that have eight or more hives. Collected samples are sent to the USDA Bee Research Laboratory in Beltsville, Maryland where they are tested for exotic pests, pathogens, and pesticide residues. Sample processing takes time, so results are not typically available until the following year.

To date, no exotic pests or pathogens have been detected in Utah. Data collected thus far have mirrored state-collected data and demonstrate that average Varroa mite infestations consistently exceed threshold levels, especially from the months of August through October. 2020 data also show that Utah's beehives have occurrences of Deformed Wing Virus B (DWV-B) at a rate higher than the national average. This is likely due to high levels of mite infestations, as DWV-B is vectored by Varroa mites.

Multiple years of analyzing secondary hive products suggests that pesticide residues in Utah's beehives are frequently below the national average. In 2020 the most commonly appearing pesticide residues are 2,4-DMPF and chlorpyrifos. The former chemical is a breakdown product of amitraz, the active ingredient in certain Varroa mite control products, so seeing this chemical in beehive products is to be expected. When used appropriately and according to the pesticide label, this pesticide is beneficial to colonies because it kills bee parasites. The latter chemical is a widely used organophosphate insecticide that is frequently applied to almonds, corn, and fruit orchards and is acutely toxic to bees. Because many of Utah's beehives are annually shipped to California for almond pollination, it is possible that colonies are exposed to chlorpyrifos during their time in the almond orchards.

In 2021 state inspectors completed 14 NHBS samplings statewide. The complete results of this survey can be viewed at the Bee Informed Partnership website: https://research.beeinformed.org/state_reports/

Figure 3.
Adult bee sampling.

Figure 4.
Larval bee sampling.

Figure 5.
Pollen sampling.

Figure 6.
Weed removal.

Figure 7.
Honey bee visiting a dandelion.

Figure 8.
Weed removal.

Pollinator Protection Efforts

In response to high-profile concerns about pesticide misuse and the associated negative impacts on bees, UDAF brought together beekeepers, commercial food growers, pesticide applicators, landowners, and the general public to create a Managed Pollinator Protection Plan (MP3) in 2015. The MP3 promotes practices that will reduce pesticide exposure to bees, facilitates communication between stakeholders and encourages people to plant pollinator-friendly flora. This is accomplished via public presentations, trainings and the distribution of educational literature. Since the program's implementation, the state has undertaken extensive education and outreach efforts. Unfortunately, as was the case last year, these efforts fell short of previous years' work, primarily due to COVID-19-related restrictions on group gatherings and other public health guidelines. Nonetheless, there are many accomplishments to report.

First, the UDAF Apiary Program presented virtually at the Utah Weed Control Association annual convention in February. Members of this group are responsible for combating the 54 weed species deemed noxious by the state of Utah. Weed abatement activity such as applying herbicide is generally considered by scientific authorities as a peripheral concern in bee health, since herbicides typically work on plant specific biochemical mechanisms and are not acutely toxic to bees. In fact, most herbicides do not have any label instructions specific to preventing bee exposure, due to their low acute toxicity to these insects. However, in recent years there has been concern in scientific circles about the potential sublethal effects of herbicide exposure on these insects. Sublethal effects are those which don't outright kill a bee, but may have deleterious effects on navigation, learning and/or development. On occasion, there is also concern that weed abatement activities may remove forage sources for bees.

At the virtual event, the over 100 people in attendance were given an overview of the various threats to honey bee health, some basic bee biology, trends in bee exposure to herbicides and information regarding the documented sublethal effect risks to bees associated with herbicide exposure. This was followed by some practical steps that attendees could take to reduce bee exposure to weed control products. Suggestions included avoiding spraying flowers in bloom (when possible), preventing herbicides from drifting in the wind, using the least hazardous formulation, and replacing weeds with native and naturalized plants. The presentation encouraged weed controllers and beekeepers to work together and find mutually beneficial solutions, as well as to learn more about the importance of each other's role in Utah agriculture.

Another major aspect of MP3 efforts in 2021 included work the UDAF Apiary Program did to minimize impacts of the Japanese beetle eradication (see page 14) activities on bees. The eradication effort involved applying insecticide to nearly 400 acres of irrigated turf across numerous Wasatch Front counties. Although grass is not bee pollinated, the presence of blooming weeds, visited by bees (Figure 7), intermixed with turf presents an exposure hazard to when pesticide is applied. As a result, state bee inspectors devised comprehensive mitigation plans to reduce this hazard (Box 2).

BOX 2: How Pollinators Were Protected During 2021 JB Treatments

- Employees from both contracted pest control companies were required to attend a pollinator protection training, which outlined specific actions that reduce bee exposure to insecticide.
- Clorantraniliprole, an insecticide with low acute toxicity to honey and native bees, was used for the vast majority of the acreage treated.
- Imidacloprid, a pesticide that has high acute toxicity to bees, was used sparingly.
- In the occasional case where imidacloprid was used, teams were sent ahead of the applications to remove flowering weeds that would potentially attract bees (Figures 6 and 8).
- Parcels that presented extreme exposure risks to bees were removed from treatment plans, regardless of which insecticide was used.
- The registered beekeeper list was utilized to contact apiarists within two miles of the eradication areas, to inform them of upcoming insecticide applications.
- Free screening material was offered to beekeepers that wanted to keep their bees inside the hives during insecticide applications.
- Advice was given to beekeepers that wished to move hives during applications.

The UDAF Apiary Program did not receive any reports of bee kills or even sub-lethal injury to bees after any of the applications. This suggests that measures taken sufficiently protected bees inside and adjacent to the eradication areas. The UDAF Apiary Program intends to continue these mitigation efforts as long the Japanese beetle eradication proceeds.

Honey Bees and Antibiotics

As a response to the growing threat of antibiotic-resistant strains of pathogens, the U.S. Food and Drug Administration implemented the Veterinary Feed Directive (VFD) rule in 2017. This rule established new requirements for the use of antibiotics in animal feed. Over the past three years this change has significantly impacted beekeepers by restricting their access to antibiotics and prohibiting prophylactic use in most cases. Perhaps the most substantial requirement of the VFD is that beekeepers are now required to go through a veterinarian to access antibiotics. Previously, beekeepers could purchase these products over-the-counter. This change has likely been a significant contributing factor to Utah's elevated rates of AFB and EFB diseases in recent years.

To lessen the impact of the new regulations on beekeepers the UDAF Apiary Program has been educating veterinarians about their new responsibilities, facilitating communication between stakeholders and providing timely pathogen test results. The addition of molecular disease diagnostic capabilities to the UDAF Entomology Lab (see page 24) in 2018 was critical in the success of this effort; now veterinarians and beekeepers can expect to get highly accurate test results in days rather than weeks.

The highest density of beekeepers in the state is in Salt Lake County - which was previously the one county with a glaring lack of bee-friendly veterinarians. In 2021, significant efforts were made to identify veterinarians that are willing to work with beekeepers in the Salt Lake area. One new veterinarian based in Salt Lake City was identified. The department will continue to reach out to veterinarians in the Salt Lake area, focusing particularly on vet students and those seeking continuing education in the field of honey bee veterinary medicine.

Africanized Honey Bee

In 2008, Africanized honey bee (AHB) *Apis mellifera scutellata* (Lepeletier) was first detected in Southern Utah. The UDAF Apiary Program promptly responded by monitoring its spread through the state. Though AHB can be dangerous, this honey bee subspecies is unfairly sensationalized in the media. In Utah, there have only been a few instances of AHB attacking humans or animals. The UDAF Apiary Program is committed to ensuring that all stakeholders are made aware whenever AHB moves into new areas. The counties with known established AHB populations are: Emery, Garfield, Grand, Iron, Kane, San Juan, Washington, and Wayne. State inspectors continue to track movement to new areas by testing feral bees and aggressive managed colonies regardless of their location in the state. No new county records were found in 2021. Nevertheless, if a person has no experience managing bees, it is best practice to keep clear of any encountered honey bees and to treat all colonies with the respect they deserve.

Health Certification

The UDAF Apiary Program offers health certification services to registered beekeepers in the state. These certificates can be used for various purposes. For instance, many states require that imported colonies are inspected prior to arrival and certified free of certain pathogens or pests. Depending on requirements of other states, certificates may be needed that confirm hives are free of AFB, SHB, or other regulated pests (see page 28). Other beekeepers utilize health certificates to maintain eligibility for federal farm assistance programs. Also, some merchants that sell honey bees within the state will request a health certificate so that customers can be assured that purchased bees are free of disease. In 2021, state inspectors certified 428 hives to meet the import requirements of other states, 291 hives were inspected for federal relief programs, and 20 hives were certified as disease free for in-state sales.

Asian Giant Hornet

A new threat to honey bees is on UDAF's radar: the Asian giant hornet *Vespa mandarinia* (Smith). It is the largest hornet in the world and poses a great danger for both honey bees and humans alike. It is endemic to Asia but has recently been detected in Washington state and British Columbia. Multiple reports of human fatalities caused by *V. mandarinia* stinging incidents have caused the wasp to be colloquially called the "murder hornet." *V. mandarinia* is a voracious predator of honey bees, and its hunting tactics can decimate an entire honey bee colony within a matter of hours. The UDAF Apiary Program recognizes *V. mandarinia* as a significant threat to Utahns and their honey bees and is investigating supposed sightings of the invasive insect in the state.

Habitat suitability models predict that, if left unchecked, *V. mandarinia* could rapidly become established throughout North America. Regions with high human activity, a temperate climate, and frequent precipitation are most at risk. Unfortunately, there are no established survey protocols for monitoring this insect, so the department is relying on the public to report any potential *V. mandarinia* sightings. In 2021, dozens of reports were received of potential *V. mandarinia* sightings, but all reports were confirmed to be some other species of insect (Figure 9). Indeed, there are many insects native to Utah that are visually similar to *V. mandinaria* (Box 3). There are currently no records of *V. mandarinia* in the state of Utah. Individuals who may have spotted *V. mandarinia* are encouraged to contact the UDAF Apiary Program.

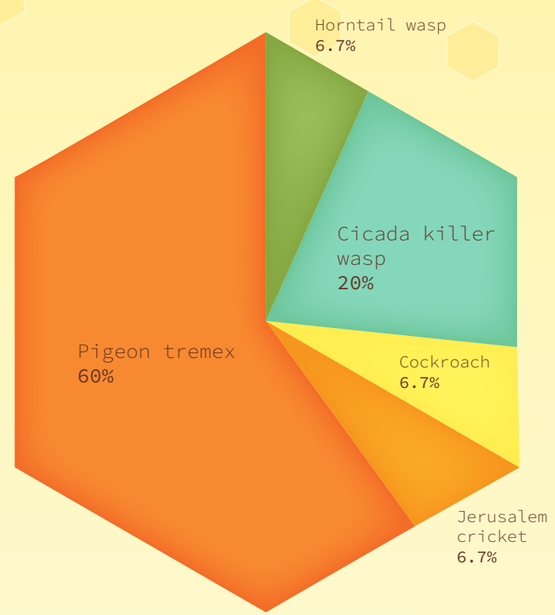
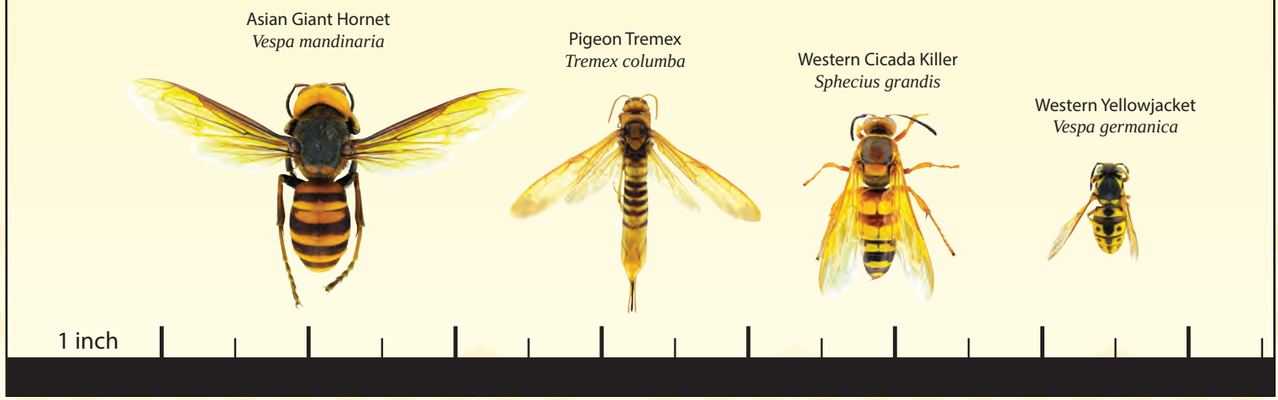
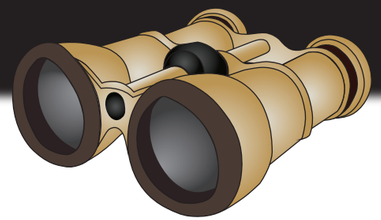


Figure 9. Percentage of suspected V. mandarinia sightings by actual insect identification.

BOX 2: Morphological comparison of Asian Giant Hornet and common native wasps.



INVASIVE MOTH WATCH



Moths tend to attract less attention than their more charismatic Lepidopteran relatives – the butterflies. For example, "butterfly gardens" are commonly grown by horticulturalists; yet "moth gardens" have yet to catch on. It is difficult to know why this is. Moths, such as those in the family Saturniidae, can have colors and patterns that are just as brilliant and interesting as any butterfly. For proof, do an internet image search for the luna moth *Actias luna* (Linnaeus) or the rosy maple moth *Dryocampa rubicunda* (Fabricius). Maybe people are less interested because most moths are active in the night, when people tend to be asleep. Or perhaps, people are just as interested in moths as they are butterflies, but the attention they receive is not by and large positive. Indeed, by some estimates, 70% of agricultural pests are moths, which certainly makes them the subject of much attention. By comparison, there are relatively few butterfly pests. Although the Utah Department of Agriculture and Food (UDAF) Insect Program recognizes the many benefits that the vast majority of moths provide, our attention, like many others, focuses on the problematic varieties. Specifically, the program takes actions to prevent the introduction of two specific invasive moths which are economically and environmentally destructive: the insect formerly known (see Box 1) as the European gypsy moth (GM) *Lymantria dispar dispar* (Linnaeus) and the European corn borer (ECB) *Ostrinia nubilalis* (Hübner).

National and Utah History

GM is perhaps the best-known defoliating moth in America. On a quest to find a better silk-producing moth, an amateur entomologist imported GM into the United States (U.S.) in the 19th century. The idea was to find a moth that could produce silk as economically as the silkworm *Bombyx mori* (Linnaeus), but would also be resistant to the many diseases which inundated commercial silk production. Some of the adult moths accidentally escaped their containment and began defoliating trees in the nearby city of Medford, Massachusetts. By 1902 the pest had spread throughout much of New England and in subsequent decades it became established in the Mid-Atlantic. Today GM is still present in these areas and has infested some parts of the Midwest and South.

GM is arguably the most devastating forest and shade tree pest in the Eastern U.S. It prefers hardwood trees, such as aspen *Populus spp*., linden *Tilia spp*., oak *Quercus spp*., and willows *Salix spp*., but like many defoliating moths—it isn't picky. GM can feed on over 300 different trees and shrubs. Established populations will fluctuate year-to-year, with some seasons being worse than others.

Utah has had multiple encounters with this pest, all of which ended with the insects being successfully eradicated. In 1988, GM was detected at the University of Utah campus in Salt Lake City and high density trapping later found moths in surrounding areas (Davis, Summit, and Utah counties). A multi-agency effort between the UDAF, United States Department of Agriculture (USDA) Forest Service, USDA Animal Plant Health Inspection Service (APHIS) and Utah Department of Natural Resources (DNR) financed the treatment of 72,000 acres of public and private land over a five-year period (1989-1993). By 1994, no moths were caught in any of the thousands of detection traps placed; the next year yielded the same result. Yet, just two years later, seven GM were detected in Salt Lake County locations where the moths hadn't previously been found. As a result, more than 1,600 acres would be sprayed over a two-year period (1998-1999) to eliminate these newly found populations. By the year 2000 the multi-year, multi-million-dollar eradication effort was proclaimed a success and no moths have been found in previously infested areas since.

Though, it has never been detected in Utah, ECB is also of great importance to UDAF. The pest was first found in Boston, Massachusetts just over 100 years ago. It is thought to have made its way into the country on broom corn *Sorghum spp*. imported from Hungary and Italy. Over the years, the pest spread throughout the East and Midwest and became a serious pest of corn *Zea mays*. During most of its history in the U.S., the pest was notoriously difficult to control because the larvae bored into cornstalks and therefore was protected from insecticide applications. An assessment of ECB damage published in 1996 put the annual costs due to yield loss and control measures at $1 billion annually.

However, the situation was dramatically improved with the extensive adoption of transgenic *Bacillus thuringiensis* (Bt) corn by growers in the late 1990s. Many infested areas have reported steep declines in ECB populations since this technology became widely utilized in corn growing and the seriousness of the pest has been downgraded. Despite this success, there is concern that ECB may develop resistance to Bt corn. If, in the future, transgenic corn is no longer effective in controlling ECB it will likely become a pest of great importance once again. Furthermore, ECB continues to cause major damage to other plants, such as peppers *Capsicum annuum*, certain ornamental plants, and non-Bt corn.

BOX 1: A New Name is on the Horizon for GM

On July 7th, 2021, the Entomological Society of America (ESA) announced that it would be changing the common name of the infamous Lepidopteran *Lymantria dispar dispar*. ESA has maintained a list of insect common names for over a century and is considered the official naming institution for hexapods in the U.S. Dropping the common name "gypsy moth" was in response to concerns from the Romani community, which objected to the use of an ethnic slur in the labeling of a widely known (and detested) insect pest. ESA is in the process of establishing a new common name. UDAF plans to alter state literature, once a new common name is announced and it is adopted by USDA APHIS.

Quarantine Efforts

Utah has a suitable climate and an abundance of host material for both of these moth pests to thrive. Thus, UDAF takes many measures to prevent their introduction. UDAF administers a GM quarantine (Utah Administrative Code R68-14) of transportable articles that may harbor the pest. This rule requires inspection of household items, firewood, Christmas trees, and vehicles that are entering the state from quarantined areas of the country. Every year, agricultural inspectors visit Christmas tree lots to inspect for GM and other pests. Firewood for sale at retail locations is also regularly inspected. Similarly, UDAF also enforces an ECB quarantine (Utah Administrative Code R68-10). These rules regulate the import of corn, broom corn and other host plants from infested states.

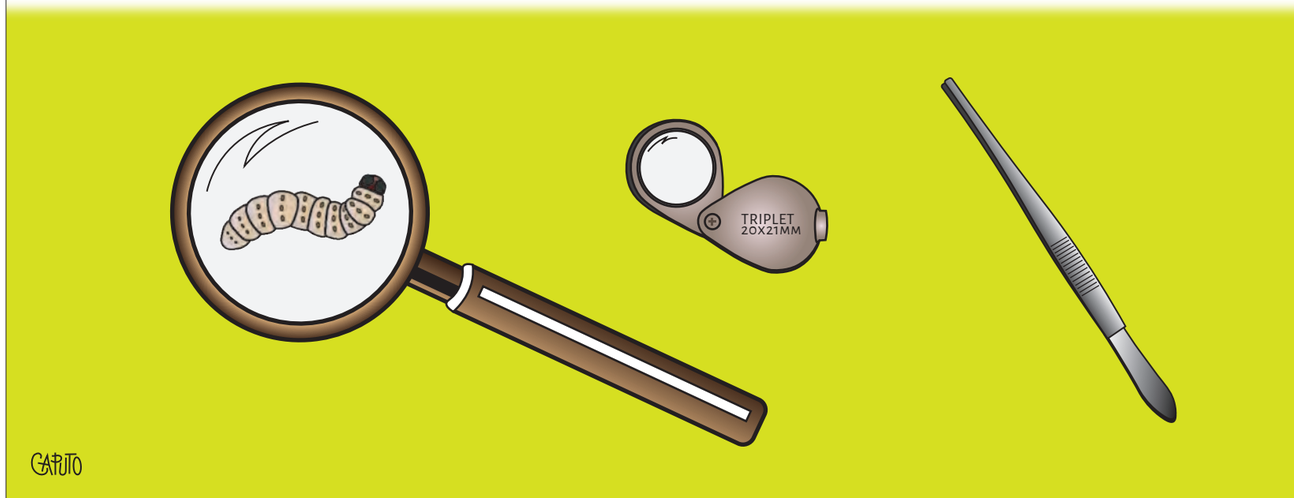
Recent Trapping Efforts

Since GM was eradicated, the UDAF Insect Program has been vigilantly monitoring for new GM introductions into the state by annually placing thousands of pheromone-baited traps across Utah's 29 counties. Much of the funding for these activities comes from a USDA APHIS grant. From the period of 2008 to 2015, not a single GM was captured. In 2016 one moth was caught in Davis County, but subsequent high-density trapping did not detect any others. In 2020, a single moth was detected in West Jordan in Salt Lake County. In 2021, a high-density grid of traps was deployed around the capture sight, but no GM were found. 2,139 standard detection traps were dispersed throughout all of Utah's 29 counties. No GM were found in any of these traps either. In 2022, standard detection trapping and the West Jordan grid will be continued.

The program also conducts an annual trapping survey for ECB. As previously mentioned, ECB has never been detected in Utah and 2021 trapping efforts yielded the same results: a total of 84 traps were set amongst Box Elder, Cache, Davis, Duchesne, Emery, Grand, Morgan, Sevier, Uintah, and Utah counties, and no ECB were found.

USU Takes on Asian Defoliator Survey

While efforts to protect Utah from GM and ECB introductions are ongoing, there is also work being done to prevent other agriculturally destructive moths, which are not known to be established in the U.S., from entering the country. While GM is from Europe, there are other closely related moths from Asia (*L. dispar asiatica* [Vnkovskij], *L. monancha* [Linnaeus], *L. mathura* [Moore], *Dendrolimus pini* [Linnaeus]), which are also serious threats to urban and natural forests. For more than a decade, UDAF participated in survey of these high-risk pests, funded by the USDA Farm Bill. However, in 2020, UDAF did not apply for federal funds to conduct survey work and placed only a small number of traps in high-risk areas such as rail yards and airports. In 2021, due to demands of the ongoing Japanese beetle eradication (see page 14), UDAF dropped the survey entirely and no traps for these pests were placed anywhere in the state. In order to continue this important work, the Utah State University (USU) Biology Department has applied for federal funding and intends to conduct a full survey for these pests in 2022. To facilitate this transition, UDAF will provide technical guidance to USU as they take on this work.



THE EPIC BATTLE CONTINUES AGAINST...

THE STATE ENTOMOLOGIST HAILED THE [illegible]

LET'S SPLIT UP INTO TEAMS

THE TRUCKS ARE PREPARED...

The multi-county infestation is on the decline as the state completes a second year of eradication activities

GARUTO

...BUT VAST TURF REMAINS!

THE WATER IS FLOWING NOW!

JAPANESE BEETLE

MEANWHILE IN INFESTED STATES...

[illegible]CED

BEETLE BI GONE

OH NO! THEY ARE AFTER THE MARIGOLDS... GET THE MALATHION!

5¢

UDAF COMICS

POOR PEST MANAGEMENT OCCURS

During the summer of 1916, two New Jersey agricultural inspectors noticed some peculiar looking beetles feeding on hawthorn *Crataegus spp.* at a nursery near the Delaware River. Months later, they were confirmed to be invasive insects. The newly detected critters would later be named Japanese beetles (JB) *Popillia japonica* (Newman). The insects likely "hitchhiked" their way to the nursery on imported Japanese irises *Iris spp.*. It is not known whether the inspectors truly understood the scale of destruction that would befall a medley of ornamental, fruit, and vegetable plants, within eastern states, in the decades to come. However, it is evident that they knew these insects would be problematic to some degree. The beetles were indigenous to Japan and horticulturalists in that country were familiar with them. The inspectors had two Japanese books translated into English, which described the beetles as being pests of beans (various genera), grapes *Vitis* spp., peas *Pisum sativum*, and peanuts *Arachis hypogaea*. Consequently, in 1918, they devised a plan to eradicate the nascent population and requested financial resources from the state of New Jersey to fund the project. Ultimately, they would be given a mere one-third of what they requested ($5,000 was provided). In addition to being underfunded, they also faced a nursery owner that was vehemently opposed to the destruction of any infested plants and fought eradication efforts both publicly and privately. The nursery owner once falsely claimed that the damage associated with the beetles' introduction amounted to a mere $5 (in 1919 dollars). Indicative that this estimate was far off the mark, nearly a century later it was projected that infested states spent $460 million annually on JB control and plant replacement costs. Just three years after the beetles were first detected, the effort to rid New Jersey (and the U.S.) of these pests was deemed a failure and the pests spread through eastern and mid-western states during the remainder of the 20th century.

It will never be known whether JB could have been eliminated had the eradication effort been fully funded and the owner of the infested nursery cooperated. In the hypothetical realm where such a scenario occurred, growing host plants would have been easier and cheaper in areas where the pest now resides. Insecticides applied to protect plants from JB would have been used significantly less in these areas as well. Although there is no going back for the plant growers in the East and Midwest, uninfested Western states, such as Utah, live in a sort of "alternate reality" where JB isn't present. Indeed, many Utahns benefit from improved plant yields, lower growing costs and reduced pesticide use because the state is JB-free. Yet, remaining uninfested is not a fixed state. People in areas without JB must continuously take significant actions to maintain this status, such as quarantine measures which prevent introductions, surveillance to identify newly introduced populations and eradication efforts to eliminate introduced populations before they establish. All of this work results in occasional reevaluations of whether it is most prudent to either maintain exclusion efforts or to give up, as so many others have. The communities in Utah affected by all of this, weighing the costs and benefits, have historically and presently decided that the dividends of remaining uninfested far outweigh the investment required to maintain this position.

JB Biology and Host Plant Damage

The JB lifecycle begins in early summer, when a mated female digs a few inches below the ground (preferably in various genera of irrigated turf) to lay a couple of eggs. This process is repeated until 40-60 eggs are laid. By mid-summer, the eggs hatch underground and young grubs feed on turf roots and begin to grow. In late fall, the beetle grubs dig deeper into the soil and remain inactive throughout winter. By early spring of the following year, the grubs start feeding on turf roots again. Beginning in May the grubs cease feeding and pupation occurs. Adult emergence begins in June and continues until late July.

In the fall and spring months, the larval feeding on turf roots makes JB a severe turf pest. Infested grass often appears yellowed, patchy and wilted. Where damage is severe, turf may roll up like carpet because the roots have been completely devoured. Yet, JB has more than one destructive life stage. The adults also have voracious appetites and can feed on the foliage, fruit and, flowers of over 300 host plants, including many popular and economically important fruits, vegetables and ornamentals. Leaves of host plants eaten by JB will appear skeletonized because the insect eats leaf tissue but not leaf veins. Affected plants may lose vigor, experience a reduction in yield, or perish.

History of JB in Utah

The Utah Department of Agriculture and Food (UDAF) has demonstrated that it can keep the state JB-free with a multipronged strategy of prevention, monitoring and eradication of introduced populations. Prevention is achieved by the implementation of quarantine rules, which are imposed on infested states and restrict the importation of commodities that may harbor JB, such as nursery stock, turf, and soil. A "second line of defense" is an annual statewide trapping survey, which detects these insects quickly if they are introduced. Finally, if a sizable population is discovered, swift eradication measures must be taken to prevent it from establishing.

The first effective demonstration of this approach occurred in 2006 when thousands of JB were detected in Orem. The state declared an Insect Emergency Infestation (per UCA §4-35-101 et. seq.) and began intensive pesticide treatments of turf and other host plants for multiple years. As a result of this speedy response, the annual captures of JB began falling rapidly year over year. By 2011, not a single beetle was detected and just three years later it was declared eradicated. At the time, it was the largest successful JB eradication effort in U.S. history. In recent years, Idaho and Oregon have both detected even larger populations of JB and are taking substantial eradication actions to maintain their JB-free status. Idaho has eliminated their infestation in Boise and Oregon continues to make significant progress in Portland.

In the years after the Orem eradication, the number of JB traps annually placed was substantially increased in Utah so that introduced populations could be detected even earlier than before. The number of standard detection traps (those placed for routine monitoring) more than tripled and the survey began to include all of Utah's 29 counties. Previously, only high-risk counties were trapped. Over the years a small number of beetles have been detected in areas far from Orem. Between 2012 and 2015 a few were found in Salt Lake City's downtown and in the Avenues neighborhood. Intensive trapping of these locations in succeeding years demonstrated that JB did not establish in these instances.

A New Population is Introduced

After multiple years of not finding a single JB anywhere in the state, in 2018, three beetles were found in Salt Lake City's west-side industrial district. While this development necessitated additional high density trapping the following year, it was not immediately assumed that these findings were indicative of a stable population. Indeed, it is not unusual to find a small number of recently introduced JB, conduct extensive trapping, and later find that the population never established. Unfortunately, this particular situation did not turn out this way. In 2019, over 100 traps were placed at the same location and numerous additional beetles were found. Complicating matters further, standard detection traps discovered five other locations across Salt Lake and Davis counties where JB was present. All of these areas were trapped heavily to illuminate the population size and distribution. By season's end, trappers had found 36 beetles in Salt Lake County and seven beetles in Davis County.

Although 43 beetles are far fewer than the thousands detected in the Orem infestation over a decade ago, it is certainly enough to create a permanent population if action was not taken. Consequently, the UDAF Insect Program devised a comprehensive eradication plan to ensure that the new population would not gain a foothold in the state. The plan focused on treating irrigated turf in the infested areas. This host material was targeted because it is a favorable medium for the pest's early life stages. While the adult life-stage can be targeted for control, this approach is not nearly as effective as killing the beetle in its immature stage. Therefore, in the interest of keeping costs low and minimizing pesticide usage, the plan's guidelines prescribed treating irrigated turf. Staff utilized the previous year's trapping data as a means of determining where to target interventions and ultimately proposed treating all irrigated turf within 650 feet of a female capture or two or more beetles (male or female) captured in the same location. Numerous Salt Lake County parcels were identified as needing control measures based on these guidelines.

The first step in enacting this plan was the creation of a JB Decision and Action Committee, which first convened in early 2020. Members of the committee included biologists, county extension agents, city parks personnel, and ag-industry leaders. The UDAF Insect Program presented committee members with maps demonstrating where JB had been found in the previous year, information about the consequences of inaction and a thorough outlining of the eradication plan. The committee unanimously recommended that the plan go forward and the Commissioner of Agriculture declared an Insect Emergency Infestation, which set into motion the eradication measures. In early 2021, the committee reaffirmed support for continuing the emergency declaration and subsequent treatments were made according to previously approved guidelines.

2020 Eradication and Monitoring Activities

In spring of 2020, a total of 167 acres across 217 parcels in Salt Lake County were treated with granular imidacloprid. The JB trapping survey conducted later that year, indicated that the efforts were successful. Indeed, just 15 beetles were found in close proximity to the known sites of infestation from the previous year. This was an approximately 58% reduction in the number of captures in the same area compared to the preceding season.

While the JB population in Salt Lake County appeared at the time to have been significantly reduced by eradication measures, the JB

BOX 1. 2021 ERADICTION SAFETY AND ENVIRONMENTAL PROTECTION MEASURES

HUMAN HEALTH & ENVIRONMENTAL PROTECTION

UDAF Pesticide Program inspectors supervised all of the eradication's pesticide applications. These highly trained individuals are responsible for enforcing federal and state pesticide laws. Their work protects humans, animals, non-target insects, and the environment from irresponsible pesticide use. During any pesticide applications, these inspectors conducted "Use Inspection," which essentially involves overseeing applications and prevents applicators from performing their duties incorrectly.

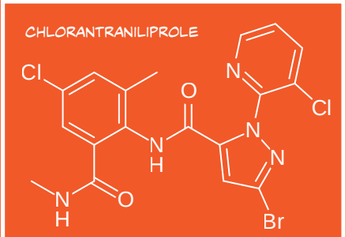
In addition, UDAF took measures to minimize exposure to persons with pesticide sensitivities. Because children are known to be more sensitive to pesticide exposure than adults, the program coordinated with schools' staff to ensure that applications could happen either after adjournment for the day or on days when class was out. Residents that had a medically-verifiable pesticide sensitivity could also request to perform a non-chemical alternative treatment on their property's turf.

PESTICIDES USED Two insecticides were selected for the eradication plan: chlorantraniliprole and imidacloprid. Utilizing more than one insecticide is line with the integrated pest management (IPM) practice of rotating chemicals as a means of reducing pest resistance pressure. If the same chemical is used continuously, the pest population may become resistant and treatments will become ineffective.

Clorantraniliprole has the distinction of being an effective JB control product with low mammalian toxicity and reduced toxicity to beneficial non-targets, such as bees and certain predacious insects. In fact, the pesticide is classified by the U.S. Environmental Protection Agency (EPA) as a "reduced risk pesticide." Because of the chemical's excellent environmental sensitivity profile, it was used in spring, when most of the treatments took place.

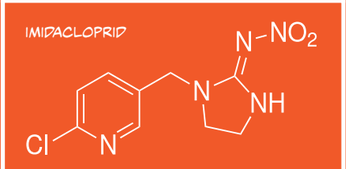
Like in the previous year's eradication efforts, imidacloprid was used because of its proven record in controlling JB and low mammalian toxicity. The downside to this chemical is its toxicity to bees and other pollinators. For this reason, the product was used only in small, higher risk areas and additional precautions were taken to protect bees.

CHLORANTRANILIPROLE



- RYANOID CLASS INSECTICIDE
- CLASSIFIED AS "REDUCED" RISK BY E.P.A.
- USED IN SPRING WHEN MOST ACREAGE WAS TREATED

IMIDACLOPRID



- NEONICOTINOID CLASS INSECTICIDE
- ONLY APPLIED IN HIGHER RISK AREAS
- USED IN FALL TO PREVENT JB RESISTANCE TO CHLORANTRANILIPROLE
- EXTRA PRECAUTIONS TAKEN WHEN APPLIED TO PROTECT NON-TARGETS

POLLINATOR PROTECTION The UDAF Apiary Program crafted strategies to minimize risk to honey bees and other pollinators. First, prior to any pesticide use, the state's registered beekeeper list was utilized to communicate with beekeepers about planned applications and provide advice and materials on how best to protect colonies. Second, the pest control companies hired for the project were required to attend a pollinator protection training prior to applications. Third, the least hazardous chemical to non-targets, chlorantraniliprole, was utilized for more than 90% of the acreage treated (see Box 2); the more hazardous chemical, imidacloprid, was only utilized for fall "rescue" treatments, where beetle populations remained stubbornly high. Finally, when imidacloprid was used, the program took the extra step of removing flowering weeds from the turf that was being treated to minimize exposure to foraging bees. For full details about these efforts see the Apiary Program section on page nine.

captures in Davis County swelled. As previously mentioned, seven beetles were found in Davis County in 2019. Four were discovered in Centerville City and three were detected in Kaysville City. Since the beetles were split between the two areas and seemed widely spaced, control measures were deferred until more trapping data could elucidate infestation centers. The 2020 trapping survey revealed the Centerville epicenter: a three-square block section of the city that included a public park and school. A whopping 49 beetles were trapped in this single area, which included large tracts of turf. Beetles continued to be captured in Kaysville, though the numbers were considerably fewer and more loosely distributed compared to detections in Centerville. A single beetle was captured near a shopping center in Farmington City and one was found in Westpoint City.

Even more concerning was that beetles began appearing in other areas of the state. In Weber County, 18 beetles were found dispersed across swaths of Riverdale, South Ogden and Ogden cities. Most were found in shopping areas, parks or at the edge of a golf course. A handful of beetles were also found in Utah County. They were about evenly divided between Lehi City's Traverse Mountain development and Provo City's Franklin neighborhood. Finally, a single beetle was found at a truck stop in Carbon County.

In Fall of 2020, the UDAF Insect Program was able to facilitate a series of "rescue" treatments in Centerville by cooperating with the Davis County School District and Centerville City. UDAF provided pesticide to these Davis County governments and their pesticide-applicator licensed employees applied the product. In total, nine acres across three parcels were treated with flowable imidacloprid.

2021 ERADICATION AND MONITORING ACTIVITIES

The UDAF Insect Program kicked off early spring of 2021 with a massive multi-county turf treatment program, which was based on capture data from the previous year. Two licensed pest control companies were contracted to apply chlorantraniliprole insecticide, in a soluble concentrate formulation, to turf in areas identified as high-risk of JB infestation. The pesticide applied was a different chemical than what was used in 2020 (Box 1 explains the advantage of switching to this pesticide). The properties involved included churches, shopping malls, schools, parks, industrial areas, low to mid-density residential, and a golf course in Davis, Salt Lake, Utah and Weber counties (see Box 2). Because only a single JB was found in Carbon County in the previous year, no treatments were made there. However, like all areas of the state where beetles are found in a previous year, the area surrounding the capture in Wellington City was heavily trapped.

Since the majority of the parcels involved were residential, a substantial outreach and education campaign was conducted to inform people about planned state activities. Residents, business owners, and other stakeholders in infested areas were mailed an informational packet with detailed information about the eradication. They were also invited to attend a virtual Open House event where they could learn about JB, how the state intended to prevent the pest establishing, and environmental and human safety precautions being taken prior to and during insecticide applications. 48 hours before the time of application, UDAF staff went door-to-door in order to alert residents of upcoming events, answer questions, and make special arrangements when necessary. Compliance by residents was extraordinary. The overwhelming majority of residents and merchants had their property's turf treated with the state-selected insecticide; just three residents elected to perform an alternative, non-chemical treatment method due to medically-verified pesticide sensititives.

In order to evaluate the effectiveness of these efforts, the UDAF Insect Program deployed a record breaking 5,315 traps, most of

BOX 2. ERADICATION BY THE #S

Insect Infestation Emergency Treatments - Spring 2021

Davis County - 210 acres - 1,075 parcels

Salt Lake County - 35 acres - 88 parcels

Utah County - 53 acres - 371 parcels

Weber County - 57 acres - 6 parcels

Voluntary "Rescue" Treatments - Fall 2021

Davis County: - 9 acres - 3 parcels

Salt Lake County -17 acres - 35 parcels

ERADICATION PROGRESS

100% ↓

Carbon County
2021 - 0 JB
2020 - 1 JB

Davis County
2021 - 15 JB
2020 - 63 JB

76% ↓

106% ↑

Salt Lake County
2021 - 31 JB
2020 - 15 JB

Utah County
2021 - 0 JB
2020 - 8 JB

100% ↓

18% ↑

Weber County
2021 - 22 JB
2020 - 18 JB

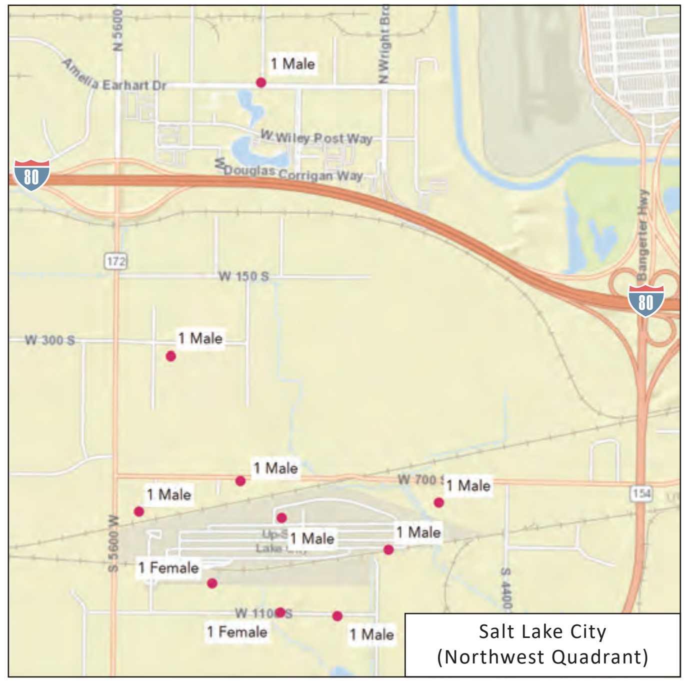
Statewide
2021 - 68 JB
2020 - 105 JB

35% ↓

2021 JB DETECTION MAPS

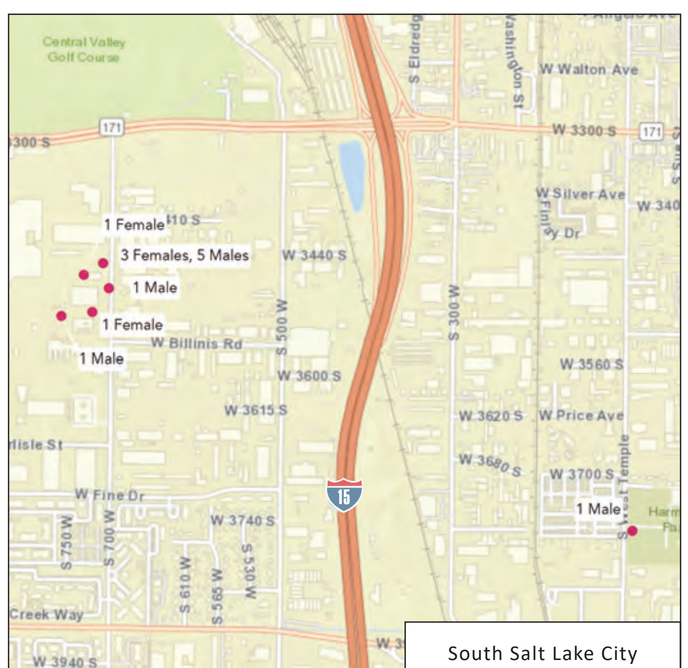
SALT LAKE COUNTY

Salt Lake City (Northwest Quadrant)



Salt Lake City (Northwest Quadrant)

South Salt Lake City



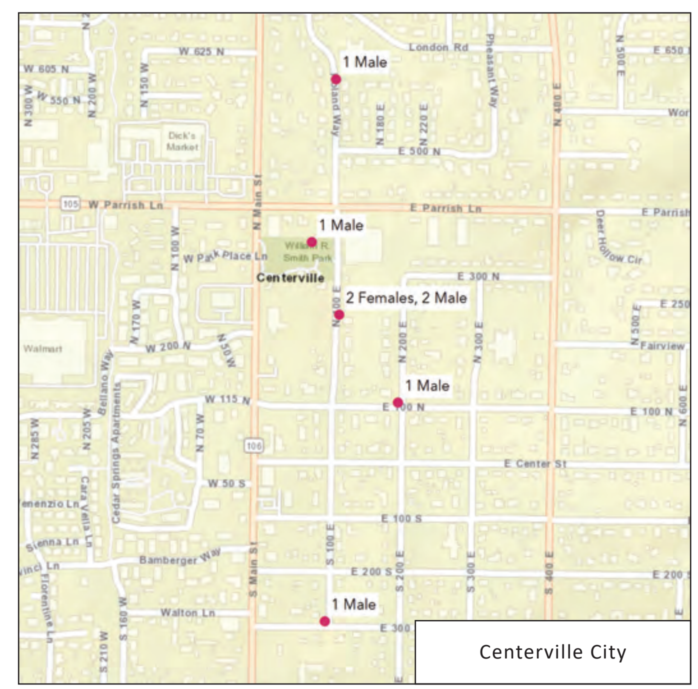
South Salt Lake City

WEBER COUNTY

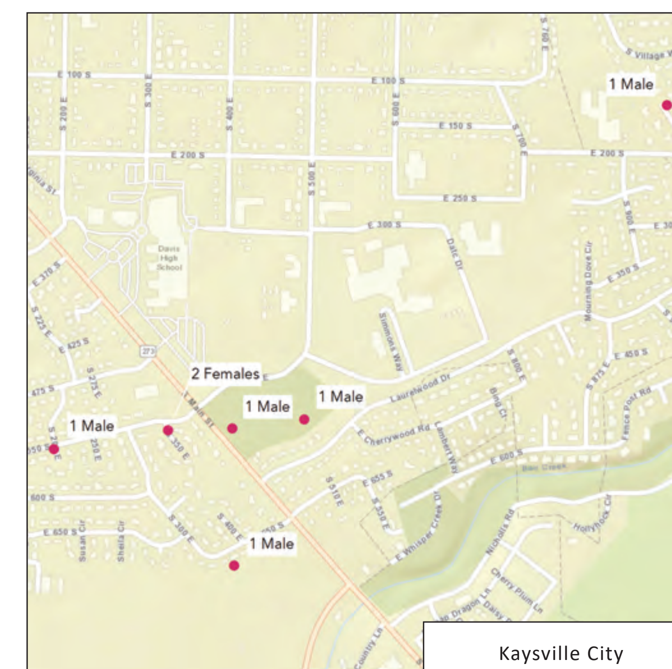
Riverdale City & South Ogden City

Uintah City

DAVIS COUNTY



Centerville City



Kaysville City

which were placed in the eradication areas. This surveillance revealed much progress from the eradication work. In Davis County, just 15 JB were found, which was a substantial decrease from the previous year's captures in this area. A slight majority of JB captured were in Centerville and the remainder were detected in west Kaysville. No beetles were found in Farmington or Westpoint cities, where single beetles were found in both places in the previous year. Perhaps the best results came from Utah and Carbon counties. Not one beetle was found in Lehi City's Traverse Mountain development or in Provo City's Franklin neighborhood, despite eight beetles being found between both communities in 2020. No beetles were found in Wellington either. This possibly indicates that the beetles are eliminated from these areas, though a second year of high density trapping with zero captures will be necessary to confirm this. Finally, in areas of Weber County where beetles had been detected in the previous year, modest reductions were achieved as well.

Yet, not all the news resulting from the survey was good. In Salt Lake County, the JB captures doubled from the previous year; nearly all of these detections were in industrial areas. Yet there was a silver lining even here: most beetle detections were close together and less dispersed than in previous years. Indeed, no beetles were found in West Valley City or Rose Park despite previous captures in both places. Since the latter area has had two years of negative trapping data it is considered officially uninfested. One other unfortunate development was that JB were detected in a new area of Weber County. Standard detection traps in Uintah City found a couple beetles early in the season; high density trapping later found others, for a total of seven captures for the season in that area.

During the fall, the UDAF Insect Program coordinated a series of voluntary "rescue" treatments with flowable imidacloprid. These applications were meant to get a "head start" on areas of most concern. In Salt Lake County, a licensed pest control company was hired to treat about 17 acres. In Davis County, UDAF partnered with Davis County governments to once again treat the Centerville epicenter.

Despite the situations where the existing beetle population grew or JB appeared in a new area, the overall trend was in the right direction. In 2021, a total of 68 beetles were captured statewide. This was a 35% reduction in beetle captures compared to the previous year and it marks the first time since 2016 where the total number of JB captured in a single season was less than what was found in the prior year. These data indicate that the recently arrived JB populations are in decline.

2022 PLANS

With beetle populations declining in most areas identified as infested, the overall trajectory of the eradication effort is positive. In 2022, the UDAF Insect Program intends to continue targeted treatments in Davis, Salt Lake, and Weber counties. All areas that have detected beetles within the last two years will continue to be heavily trapped and irrigated turf sections in known infestation epicenters are likely to be treated. The program will reconvene the JB Decision and Action Committee in early 2022 to present members with the latest findings and seek approval for new interventions.

CONSEQUENCES OF INACTION

Taking decisive and swift eradication measures in response to these recent JB detections reflects the UDAF Insect Program's invasive species intervention philosophy of "early detection and rapid response." A strategy of thorough pest surveillance that identifies exotic insect populations soon after they arrive, coupled with quick action in eliminating the pest, has great advantage over a "wait and see" approach. Invasive insect populations can grow quickly by underfunding survey activities or delaying action when target pests are found. Either tactic increases eradication costs later or permits the pest to fester so long that eradication becomes unfeasible. Consequently, in the former case the eradication "bill" to taxpayers rises and, in the latter case, huge financial burdens are placed on producers who must control a pest that was previously absent.

As previously noted, JB-infested states are estimated to spend about a half billion dollars annually in control and plant replacement costs. However, the impact on Utah's economy if the pest were to become established has not previously been thoroughly investigated. In 2019, to elucidate this unknown, the UDAF Insect Program approached the Economics Department of Westminster College located in Salt Lake City. The department assigned two senior students to build an economic model that estimated future damage costs of a hypothetical widespread infestation in the state. Although JB attacks over 300 plants, turf and corn were the focus of the project because extensive production value data were available for these plants. The results of this analysis were startling. It was determined that by the year 2027, under the most likely damage scenario, there would be cumulative costs of $234 million dollars' worth of turf injury and $1.6 million dollars in corn losses. These costs would widely fall on the state's landscape and park managers, golf courses, cities, homeowners, and farmers. Acting now, when the JB population is small, will prevent Utah's stakeholders from having to bear any of these financial burdens.

THE ORCHARD SENTINEL SURVEY

The Utah Department of Agriculture and Food (UDAF) Insect Program's orchard sentinel survey is an assemblage of three insect traps, targeting four different pests, placed at 11 commercial fruit growing sites. While some locations have been forced to move due to urban development, for the most part, these traps have been put at the same sites for over a decade. The purpose of the survey is threefold:

1) Provide early detection of invasive fruit pests not known to be in Utah.

2) Track movement of pests that are present in certain fruit growing Utah counties but not others.

3) Inform growers of the presence of certain native or established insect pests in their orchards.

Insect pests have the ability to wreak havoc on commercial fruit production; this is especially true of invasive insects. Early detection of non-established invasive insects and reliable data regarding the presence of native or established exotic pests are critical in the management of these insects. The orchard sentinel survey monitors for the following insect pests:

Apple maggot *Rhagoletis pomonella* (Walsh) is native to the Eastern United States (U.S.); the first detection in the West occurred in 1979 in Oregon. It was later found in Utah in 1985. The pest introduction likely occurred via the transport of fruit from infested states. The state of Washington maintains a quarantine of this pest to prevent it from spreading to the east of the state, most of which is uninfested. When the pest is found in Utah, it is usually in abandoned orchards or in home gardens. As the name suggests it is a pest of apples, however it is known to attack other fruits as well. Traps are deployed at the sentinel orchards to monitor populations of this pest and ensure that it does not become a severe problem for professional fruit growers. In 2021, no apple maggots were detected at any trapping sites.

Plum curculio *Contrachelus nenuphar* (Herbst) is a true weevil (family Curculionidae) native to the Eastern U.S. The insect moved from wild host material to cultivated fruit trees in the last century. Since then it has become a major pest of pome and stone fruits in its native range. In 1983, the weevil was found in Box Elder County, Utah. The pest is established in that county, but has yet to be detected anywhere else in the state. Utah is the only part of western North America with a known plum curculio infestation. The UDAF Insect Program surveys for plum curculio in Davis and Utah counties to ensure the weevil is not spreading and in 2021 none were detected in either fruit-producing county.

Light brown apple moth (LBAM) *Epiphyas postvittana* (Walker) is major pest of pome fruits and ornamental plants. It is native to Australia, but it has spread through various parts of the world over the last century. The moth was found in the mainland U.S. in California in 2007. Today 13 counties in California are under quarantine to prevent its spread. To verify that the pest has not been introduced into Utah, trapping is conducted at each sentinel survey on an annual basis. No LBAM have been detected since trapping began.

Western cherry fruit fly *Rhagoletis indifferens* (Curran) is a native insect that was first reported attacking commercial orchards in the early 1900s. It is a serious pest of Utah's commercial tart and sweet cherry industries. Western cherry fruit flies are captured on the same traps that are placed for apple maggot detection. UDAF Insect Program entomologists examine these traps on a bi-monthly basis and will inform growers if detections are made. Though it is not a quarantined pest, data are easy to collect and provide to growers. This information can be used to better time pesticide applications or make changes to pest management strategies. Western cherry fruit fly was found at three of the 11 sentinel locations; a total of 33 individual specimens were found across these positive sites.

the ENTOMOLOGY lab

The Utah Department of Agriculture and Food (UDAF) Entomology Lab came from humble beginnings - In the mid-2000s, a Japanese beetle (JB) *Popillia japonica* (Newman) eradication program and the red imported fire ant (RIFA) *Solenopsis invicta* (Buren) survey necessitated the procurement of a high-powered dissecting microscope to detect the minute morphological features that are key for species identification. In 2011, when UDAF took on the federally-funded Exotic Wood Borer (EWB) Survey (see page 34), even more help and expansion were needed. A full-time lab technician joined the insect program to sort out the thousands of beetle specimens that were caught in EWB traps. This ensured a short turnaround time for sorting through quarantine pests, which is in line with the Insect Program's "early detection and rapid response" ethos.

Today, the lab provides essential services to all of UDAF's entomology-related efforts. The lab processes all European Corn Borer (see page 12), Exotic Wood Borer, and Sentinel Survey (see page 23) trap catches. This amounts to approximately 300 individual traps that are sampled multiple times in a given season. One survey was reintroduced to the lab's purview in 2021- the Imported Fire Ant Survey (see page28). From these traps, thousands of insects are identified to species each year. Honey bee disease diagnostics in support of the state Apiary Program (see page 6) are an essential part of the UDAF Insect Program; testing services are available for five different honey bee maladies using various state-of-the-art technologies. The lab also takes hundreds of insect-related phone calls annually and offers walk-in or mail-in identification requests for potentially invasive insects.

Insect Collections are Tools for Pest Identification

Insect collections are important. Sure it may seem weird to hoard boxes of dead bugs, but there is a legitimate scientific, economic, and cultural value to keeping insect specimens stored in good conditions. The UDAF Insect Program reference collection is a practical tool for regulatory entomologists to learn which species are native to Utah, and which species may be invaders in the state. Indeed, the curation of an insect collection is one of the most important tools an institution can have in the detection of new and novel pest species. Keeping specimens for posterity can also open the door for the use of novel technologies, such as DNA barcoding as a tool to measure biodiversity change or pinpoint the introduction of novel pest species.

The UDAF insect reference collection, much like any other insect collection, provides an invaluable glimpse into the past, a snapshot of the present, and a way to possibly predict the future. Insect collections help preserve the natural history of the earth's ecology and are vital for species distribution modeling - which is why we keep all of our voucher JB specimens. The lab has a substantially larger insect reference collection than when it was started, with over 5,000 individual specimens representing 150 families of insects. New specimens continue to be added, with emphasis placed on families of agricultural and economic importance. UDAF's collection only houses a small fraction of specimens compared to the millions at the Smithsonian National Museum of Natural History. It is nonetheless useful since the collection represents Utah's own unique insect diversity. With specimen collection labels dating back as far as 1960 (See page 27 - Specimen Showcase), the insect reference collection provides a valuable historical look into species occurrences over time.

New State Woodborer Records

After every trapping season, UDAF sends specimens from the exotic woodborer survey to the Oregon Department of Agriculture (ODA) for further identification (ID) or confirmation of an ID. Entomologists that specialize in beetle taxonomy give official IDs and note where there are new state records. Identifications can take several months to get back, thus 2021 samples are still being processed. This year, we received official IDs for the specimens sent in 2020 season and there were some interesting discoveries (See Boxes 1 and 2).

Box 1

Two new (to Utah!) cerambycids found are *Anelaphus moestus* (LeConte) and *Astylopsis fascipennis* (Schiefer). Both of these species are native to the southeastern U.S., and both host on broadleaf trees such as oak, walnut, and sumac. While *A. moestus* (pictured left) and *A. fascipennis* (pictured right) are native to North America, it is still concerning that they were able to be spread outside their reported historical range. The pathways these beetles are spread are likely the same as more destructive pests, such as EAB which is established in eastern and southern states already.

Box 2

The state record from 2020 of most concern is the bark beetle *Orthotomicus erosus* (Bright & Skidmore, see page 35). This pest hosts on a wide variety of *Pinus* species. It has been established in central California since 2004, and was detected in 2015 in Nevada. 2020 marks the first year it has been detected in Utah. While the pest status has been downgraded in severity in California as no widespread damage has been observed, it is still worrying that it has moved across state lines. In its native range, *O. erosus* outbreaks are causing widespread pine tree decline due to the increase of droughts in recent years.

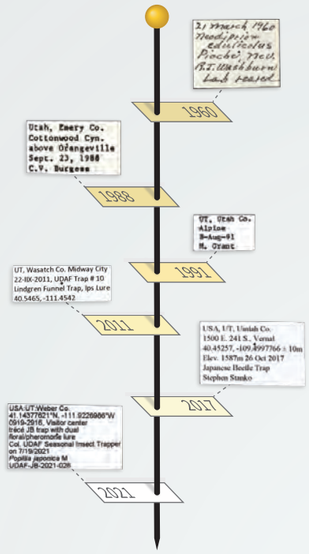


Figure 1. Timeline of insect label formats over time in the UDAF reference collection.

Labels Through History

Insect collections are only as good as the labeling systems that they adhere to - which is why insect labeling requirements have become more standardized over time and those standardizations have been slowly incorporated into the UDAF insect reference collection. Figure 1 demonstrates this label evolution, from 1960 to 2021. At first, labels were handwritten contained bare-bones location information. Different collectors made labels with their own quirks, but some key components remain constant throughout time - collection date, the nearest locality, and the collector's name. As technology improved, GPS data was incorporated and the accuracy of location data was improved. With the advent of high-resolution laser printers, labels could fit more information in a smaller space. Today's label standards include the locality, GPS information, the trap number and method of collection, the collector's name, and a unique specimen ID number.

Future projects for the curation of the UDAF insect collection are planned to further organize and add identifications for specimens that do not have any, as well as possibly digitizing the collection in a searchable database.

Small Improvements, Big Impact

In 2021, many small improvements were made around the lab that added a layer of polish to the lab's already high standards of excellence. These procedural and material improvements will be easily transferred to the new lab following the move. Two sets of micropipettes, the high-precision measuring devices used to transfer liquid reagents, were sent in for official re-calibration. The addition of a laboratory-grade label maker allowed for the implementation of a streamlined PCR sample tracking system, which is of utmost importance as the lab processes more and more out-of-state apiary samples.

Thanks to the lab staff's attendance at a USDA workshop on diagnostic entomology imaging techniques, it was learned that using grey backgrounds for specimen imaging - instead of plain white backgrounds - significantly improved the color resolution of photographs produced by the stack-shot microscope imaging system. Figure 2 demonstrates the huge differences in image quality produced by different colors of photography background. The white background produced a washed-out image with lackluster color, while grey backgrounds produced images with more color vibrancy. In the future, if the insect collection is fully digitized, this seemingly small change will make a great difference in the ability to capture color-accurate images of microscopic insects for diagnostic and reference purposes.

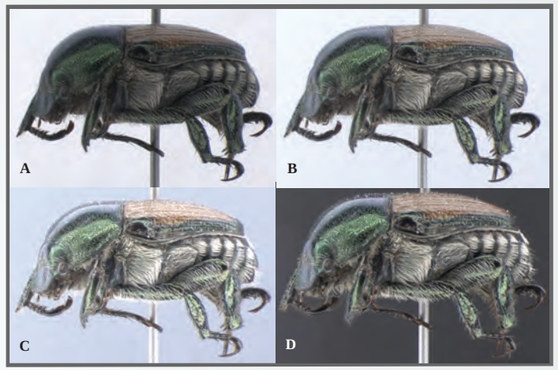


Figure 2. JB photographed on backgrounds colored (A) white, (B) light grey, (C) medium grey, and (D) black.

Changes on the Horizon

The upcoming move to the Taylorsville State Office Building and subsequent merging of the entomology and seed labs will facilitate an expansion of the reference collection's capacity. An additional entomology cabinet will be installed, bringing the total of entomology cabinets up to three . When fully stocked, these cabinets have the combined capacity to store 75 full drawers of insect specimens.

The expansion of the lab doesn't end at the insect collection - the molecular testing capacity of the new Plant Industry Lab was a key consideration in designing the layout of the new lab. Currently, the lab offers state-of-the-art quantitative polymerase chain reaction (qPCR) analysis for the identification of honey bee bacterial infections. This analytical tool is highly sensitive, meaning that trace amounts of contamination can cause false-positive results. Specifically designed "pre-qPCR" and "post-qPCR" rooms were incorporated into the new lab to reduce that contamination risk and will be key to improving the lab's already rigorous standards of cleanliness and confidence in results. Physical separation of field tools from lab tools will further reduce the risk of cross-contamination.

All of these improvements will come into play if the Plant Industry Lab ever decides to pursue International Organization for Standardization (ISO) accreditation .

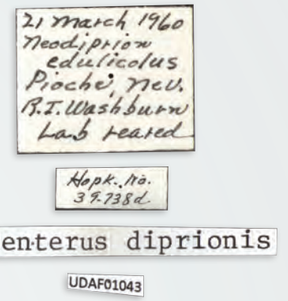
Specimen Showcase

Solving the mysterious identity of the oldest specimen in the collection

The pinyon sawfly *Neodiprion edulicolus* (Ross) is an important defoliator species that occurs throughout Nevada, New Mexico, Utah, and Arizona. The larvae of this species feed on ponderosa pine and single-leaf pinyon, the latter of which is an economically important source of pine nuts and is often cultivated as a Christmas tree. Significant damage can be done to these host trees during outbreak years. Although the trees typically survive, they are often too defoliated to sell for ornamental use.

The pinyon sawfly is just one of many types of conifer sawflies that have a "boom or bust" population cycle. The eggs lay dormant inside of pine needles during the cold winter months. The larvae emerge and begin feeding on the pine needles in April when temperatures begin to rise. Adult female pinyon sawflies deposit their eggs in the pine needles during October and early November, and the 1-year life cycle begins again. The "boom or bust" cycle of the pinyon sawfly is regulated by interannual temperature fluctuations and natural parasites of the pest - some wasps even parasitize the parasites, a phenomenon called hyperparasitism.

search on GBIF.org – a robust database of scientific names – reveals that *E. diprionis* (Rohwer) was originally described as a new species in 1915, but has since been synonymized with *E. canadensis* (Provancher). This "lumping" of species is a common occurrence in the field of entomology, especially in diverse taxonomic groups like Ichneumonid wasps. Inspecting the specimen under a microscope and comparing it to the original description of *E. canadensis* confirms that this specimen is indeed this species.



So putting these pieces together, we can conclusively re-identify this specimen from the non-existent *Extenterus diprionis* to *Exenterus canadensis*. This fascinating snapshot of history demonstrates that specimen labels, even if they are misleading, contain important information!

The insect pictured here is not a pinyon sawfly. It is a different family of wasp (Ichneumonidae) that hatched, alien-style, out of an immature pinyon sawfly. This specimen was reared in the lab from a pinyon sawfly cocoon collected in 1960 from Pioche, NV, likely near the first noted outbreak of the pinyon sawfly. Indeed, this wasp is the oldest specimen in the collection.

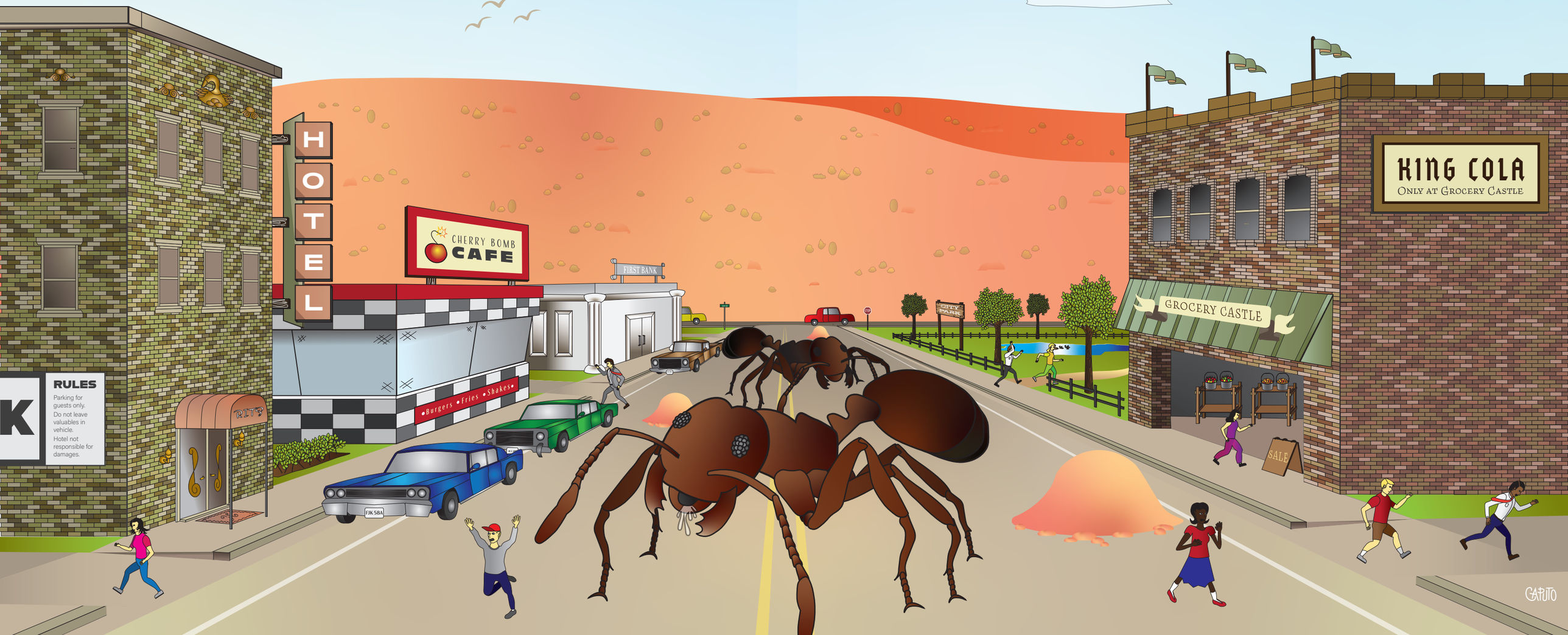
There are at least 11 known species of parasitic wasp that host on the pinion sawfly. This specimen was initially labeled as *Extenterus diprionis* – mysteriously, searching for this scientific name on the internet brings up nothing at all! How could this be? Most likely, we have here a situation of a typo combined with an out-of-date scientific name. The genus *Extenterus* does not exist, but may refer to the Ichneumonid wasp genus *Exenterus* (Hartig), which only contains two species – *Exenterus canadensis* (Provancher), and *Exenterus amictorius* (Panzer). Digging even further, a quick

Interestingly, the pinyon sawfly has a narrow temperature tolerance despite it being a temperate species. Egg survival relies on constantly cold temperatures during the egg overwintering phase. One observational study in Arizona found that there was a significant decrease in pinyon sawfly populations from 1994 to 2006, most likely caused by interannual fluctuations in April temperatures and an overall increase in average springtime temperatures. This means that if climate change continues on its current trajectory, the pinyon sawfly will be unlikely to survive in a warming climate. Good news for the Christmas tree industry, but possibly bad news for this beneficial parasitic wasp.

Attack of the...

IMPORTED FIRE ANT

The UDAF Insect Program surveys southwestern Utah for an agricultural and human health pest



BLACK IMPORTED FIRE ANT

Solenopsis richteri

RED IMPORTED FIRE ANT

Solenopsis invicta

While many people are familiar with idea of ants spoiling a picnic, they may not realize that invasive ant species can do far more damage than ruin a day at the park. Indeed, for more than a century, exotic fire ants have created serious problems in the United States' (U.S.) agricultural systems, physical infrastructure, ecosystems and public health. The two most menacing examples are the black imported fire ant (BIFA) *Solenopsis richteri* (Forel) and the red imported fire ant (RIFA) *Soleopsis invicta* (Buren). Since their introduction, they have caused billions of dollars in damages, displaced numerous native ant species and resulted in nearly 100 human deaths. Considering all of this, it is little surprise that the Invasive Species Specialist Group included imported fire ants in their global report of "100 of the Worst Invasive Species." For decades, the United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) has conducted survey, enacted quarantines and educated the public in an effort to prevent the spread of these damaging insects in the U.S. The Utah Department of Agriculture and Food (UDAF) Insect Program has contributed to exclusion efforts by conducting survey work and educating of stakeholders about pathways of introduction. These efforts are important because Utah is not known to be infested with either ant species.

U.S. History

Imported fire ants are indigenous to South America and can be found in lowland areas of Argentina, Brazil, and Paraguay. These insects began spreading to other areas of the world in the early 20th century due to the international shipping trade. In the U.S., BIFA was first found in Mobile, Alabama in 1918 and RIFA would be detected in the same area about two decades later. It is assumed that the ants arrived via soil that was being used for ballast on cargo vessels. The first official survey of these pests was conducted by USDA in 1953; it determined that imported fire ants had spread to 10 states.

In the U.S. today, RIFA infests all of Puerto Rico, most areas of eleven southeastern states and small areas of southern California and New Mexico. Despite being introduced long before RIFA, BIFA has largely been outcompeted by its more aggressive relative and exclusively infests just partial parts of northeastern Mississippi, northwestern Alabama and western Tennessee.

Biology

For the most part, imported fire ants look quite similar to many other species of ants commonly found in Utah. They measure between 1/8 to 1/4 inches, which is not remarkably large, and they are a generic reddish-brown or black color that is typical of other ants roaming around the state. A prominent characteristic shared by both species of imported fire ant is their two-segmented petiole (known as the "waist" which connects the thorax to the abdomen). However, even this feature isn't that helpful in amateur diagnostics because it is something that all ants in the genus *Solenopsis* exhibit (in Utah, there are five ants in the genus already present). Because of their similarities to other ants, definitive identification is difficult and should be done by a trained taxonomist. To a layperson, the most helpful sign of an imported fire ant colony are the gigantic mounds that are formed by these insects. Indeed, these ants make mounds that are dome-shaped and can reach 18 inches in diameter and 12 inches in height, which is substantially larger than mounds created by Utah's various ants (see Figure 1). Mounds are used to raise the colony above the water table and aid in thermoregulation; they usually do not have external openings. When mounds are disturbed by humans or animals, the ants will attack aggressively and in large numbers. Anyone believing they have found such a mound should report the sighting to USDA APHIS or UDAF.

> "Because of their similarities to other ants, identification is difficult and should be done by a trained taxonomist"

Part of imported fire ant success in prolifically spreading across the U.S. are biological features that facilitate distribution. Mating flights, where a new queen leaves her former colony to create a different colony far away, is the primary means of natural dispersal. Indeed, it takes just a single year for a colony to begin producing reproductive castes (queens and males) and less one acre can produce up to 97,000 queens per year! Yet human-mediated activities have even greater potential to spread these pests than compared to what would be achieved on their own. Essentially any product or material that is associated with soil and is movable can harbor colonies and serve as a delivery vehicle. USDA APHIS has identified many agricultural products as being high risk of transporting these insects, including: nursery stock, grass sod, baled hay, farm equipment, and even beehives (which can pick up soil after being placed in a field). In the absence of active containment measures, it is estimated that both natural and human-mediated activities contribute to these pests spreading approximately 30 miles per year.

Damage

> "...infested U.S. state and territories collectively spend about $5.6 billion annually in damages [from imported fire ants]"

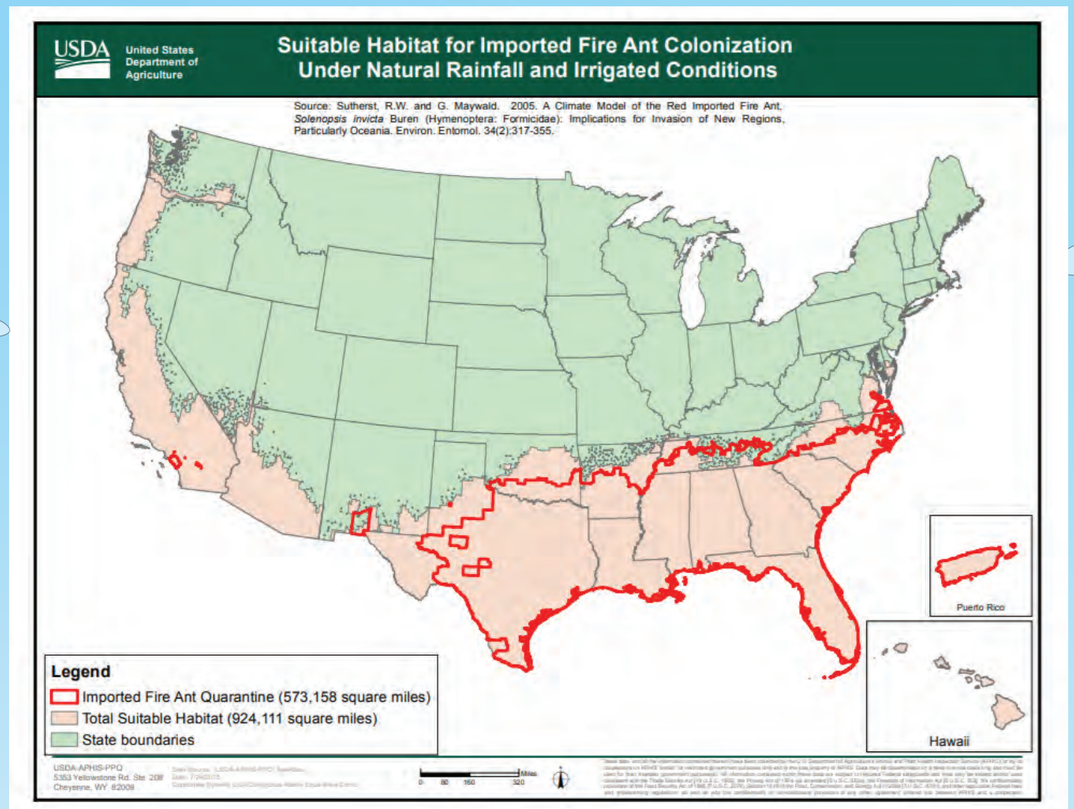
Imported fire ants are not without any merit. For example, they are known to attack cotton *Gossypium spp.* and soybean *Glycine max* pests and effectively aerate soil. Yet if there was a metaphorical ledger that documented the aggregate costs and benefits of these insects, the expenses would far outweigh the profits. Because they have such a broad potential for menace, it is difficult to fully capture how problematic they are. They attack plants such as corn *Maize spp.* and tree fruit making them serious agricultural pests for certain producers. The large mounds they create causes unacceptable damage to golf course fairways, grassy areas in parks and turf at commercial sod farms. These ants can interfere with telecommunication and electrical infrastructure because of their attraction to electrical equipment. The mere presence of large numbers of these ants can cause switching mechanisms to malfunction; soil moved by the ants and deposited in utility housing can cause corrosion and ultimately malfunction transformers. They even impact airports by chewing on cables that light the runway and digging below the tarmac, which creates potholes. The injury is so vast that a 2006 Texas A&M study estimated that infested U.S. states and territories collectively spend about $5.6 billion annually in damages.

Figure 1. Imported fire ants create large, unsightly mounds in various landscapes. They can also cause damage to electrical and utility equipment.

Yet it isn't just plants and property that are affected by these ants. Humans, pets, livestock, and wildlife can also be injured by the ants' infamous sting and other activities. Stings are venomous, have necrotic activity and causes "fire-like" pain. After being stung it is common for humans to develop white pustules on the skin, which can result in secondary infections. Because the ants attack in such great numbers, a person's appendages can be covered in these pustules after an encounter. Every year millions of Americans are stung by these insects. Thousands of those suffering stings will require medical attention and small number of people may die due to anaphylactic shock. Livestock are similarly affected. Like with humans, stings can result in injury or death to cows, horses and chickens, with the youngest animals being most vulnerable. Even if stings don't kill an animal, they can reduce productivity. For example, hens attacked by imported fire ants have exhibited reduced egg laying. Finally, wildlife can be impacted just as dramatically. Imported fire ant attacks on birds, reptiles and mammals are well known. However, competition with these animals for shared food sources is a less obvious reality. There is great concern that these activities are affecting particular species on a population level. One example of this is the iconic Texas horned lizard *Phrynosoma cornutum*, which has experience population declines for decades and was consequently listed as "threatened" by the Texas Parks and Wildlife Department (TPWD). Numerous scientific assessments and an internal review by TPWD have suggested that RIFA has been a significant contributing factor to the lizard's decline, primarily as a result of the ants outcompeting the lizard for shared food resources.

Federal & State Mitigation

There have been various attempts to eradicate imported fire ants after their introduction to non-native areas. Most of these efforts have failed, but there are a few examples of success. From the mid-1940s through the mid-70's, various infested southern states tried to rid their areas of these insects to no avail. For instance, in the late 40's Tennessee eradicated a small infestation in Shelby County only to be reinfested years later. More recently, California attempted a state-wide eradication that was overall unsuccessful, yet local governments such as Orange County are continuing these efforts. New Zealand successfully eradicated RIFA from its country. However, it only involved a few colonies that were detected at seaports soon after introduction. The most promising largescale success has been demonstrated in Australia, where the national government has eradicated four separate RIFA infested areas, including a population that had a foothold of over 20,000 acres in the Port of Brisbane. The country still has many other infested areas, but the campaign recently secured nearly half a billion U.S. dollars to fund activities for another decade. As is the case with many exotic species eradication efforts, the more quickly



an imported fire ant population is detected, the more feasible it is to eliminate these pests.

Preventing areas from becoming infested is easier than trying to eliminate them once they are detected. With that thinking in mind, in 1958, USDA APHIS enacted a quarantine of infested areas, which regulates the exchange of articles that may harbor such pests, including soil, grass sod, baled hay, and other materials. The federal quarantine currently spans over half a million acres, which is approximately 60% of the total suitable habitat for these pests in the U.S. Since nation-wide eradication is no longer feasible, the goal of these regulations is essentially to "slow the spread" of the pest, which gives uninfested areas opportunity to either exclude the pest or prepare for infestation. Some local governments in infested areas have suppression programs, which are not meant to eradicate these insects but rather to continuously reduce populations to an acceptable level.

Efforts in Utah

A number of studies have been conducted to determine the feasibility of imported fire ant establishment across the U.S. These models principally consider the ants' temperature and rainfall needs. While most of Utah appears to be unsuitable for these pests, parts of Iron, Kane and Washington counties have favorable habitat.

Since the mid-2000's USDA APHIS has funded local survey efforts to monitor for imported fire ant introductions. Because Utah's southwest portion of the state is at risk of establishment, various institutions have applied for these funds over the years to conduct monitoring. After almost a decade of Utah State University (USU) Biology Department conducting these surveys, UDAF took over these duties in the fall of 2021. Consequently, state agricultural officials set traps and conducted visual survey at 36 different high-risk locations in Washington County. Approximately 20 samples from these traps were collected, screened and pre-identified at the UDAF Entomology Lab. Seven different genera were identified, including ants in the *Solenopsis* genus. While none of these were thought to be target species, some ants were sent to taxonomists at the Smithsonian Museum in Washington D.C. to confirm this. That lab confirmed that neither BIFA or RIFA had been detected, however they did identify some of the submitted specimens as *Solenopsis geminata* (Fabricius). While this species is not a quarantined pest, it is a remarkable new state record. With early detection efforts such as these, continued education of stakeholders and the federal quarantine in place, it is hoped that Utah will remain free of BIRA and RIFA for many years to come.

Grasshopper and Mormon Cricket Suppression

The Utah Department of Agriculture and Food (UDAF) strives to protect farmers and ranchers from rangeland pest infestations by supporting suppression efforts on private range and crop land throughout the state. Utah has been suppressing populations of endemic pests such as grasshoppers (various genera) and Mormon crickets Anabrus simplex (Haldeman) since it was a territory well over 100 years ago. Rangeland pest populations are historically significant because they cause widespread damage to crop and rangeland habitats throughout the west. While populations are cyclical and difficult to predict, producers must be vigilant to identify pest populations early in order to perform necessary treatment measures. For best results and to take care of reoccurring populations, rangeland pest must be treated during the earliest life stages, before they become adults and lay eggs. Scientific authorities estimate that rangeland pest populations may persist for 5-21 years if not controlled or managed.

UDAF had reports that grasshopper populations were particularly bad in some states and perhaps the worst populations experienced in a long time. Fortunately, Utah populations were nowhere near record highs with only 453,692 total infested acres statewide for both grasshoppers and Mormon crickets. However, while overall populations may have been low, many counties did see an increase this past year and with the driest year on record, forage was low making average or even low populations economically challenging on Utah producers. UDAF had more producers reach out in 2021, than in 2020, although the sttate had roughly half the infested acres than the previous year. The counties hit the hardest were Duchesne, Box Elder, and Sanpete.

UDAF supported suppression efforts for nearly 48,000 acres by providing bait to stakeholders in 20 of 29 counties. Bait is a good suppression strategy to help mitigate encroaching populations from adjacent properties and landowners not participating in suppression efforts. It is best used as a targeted approach on small acreage or for creating borders, buffers and boundaries when protecting a particular crop, range or area.

When targeting large areas, using other chemical treatment measures becomes more efficient and effective. The UDAF cost share program reimburses applicants for treating grasshoppers and Mormon crickets by providing reimbursement of costs for their preferred pesticide. UDAF approved nearly 150 chemical cost share agreements in 2021 for a total of 54,284 acres treated.

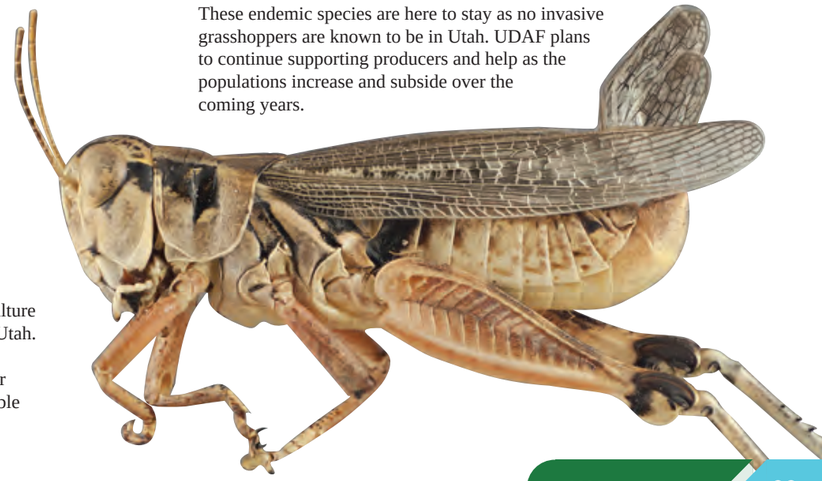
The UDAF grasshopper and Mormon cricket suppression program is available to any agriculture producer with property located in the state of Utah. If the department determines that an applicant qualifies under this program, UDAF will either provide bait free of cost or reimburse the eligible participant for 100% of the costs of chemical for aerial applications (chemical only). Cost for the application of the chemical or bait, or costs involved with labor and application of the chemical or bait are the participant's sole responsibility. Applications must be approved and agreed upon prior to treatment. It is the applicators responsibility to follow through with the terms of the agreement and seek reimbursement from the state prior to the agreement deadline. The agreement is subject to change based on funding and need.

While Mormon cricket populations remain relatively low, it does seem as if the infestations of both problematic pests (grasshopper and crickets) will impact the state for the next several years before cyclical populations naturally decline. UDAF hopes that this is not the case and that the state will have above average snow falls and spring precipitation, bringing tall grasses and high yields so all species may benefit.

UDAF attended three grasshopper stakeholder meetings all in Duchesne County, while the first one had little attendance the last one had around 200 people and roughly 100 cost share participants were approved that night. This effort was the largest collaborative effort between the county, Utah State University (USU) Extension and the state with nearly 23,000 acres treated in 2021. Other large projects included Box Elder Co. (16,500 acres) and Sanpete Co. (9,000 acres). There were efforts across the state dealing with more isolated rangeland pest's problems on a smaller scale.

The best way to get group projects like this to take place is to call a meeting of stakeholders anticipating farm and rangeland defoliation from these pests. When calling the meetings, UDAF requests to be included as we strive to support producers helping to suppress these pests through our cost share program. Others institutions that should be invited to such meetings are USU Extension and USDA APHIS PPQ. This ensures that efforts can be collaborative and that the best support possible is provided.

These endemic species are here to stay as no invasive grasshoppers are known to be in Utah. UDAF plans to continue supporting producers and help as the populations increase and subside over the coming years.



EXOTIC WOOD BORERS

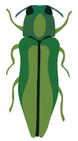
UDAF surveys for wood boring beetles that damage urban and natural forests

North American forests have been put under immense ecological strain in the last two decades due to ongoing droughts that seem never ending. Persistent drought conditions not only increase the chance of wildland fires, but also decrease a tree's ability to fight off pathogens and arthropod pests, both native and invasive. Because of this, it is more important than ever to monitor for exotic insects being introduced to Utah's natural and urban forests to protect the landscape for current and future generations to enjoy.

Wood-boring beetles are one of many major biotic causes of forest disturbance. However, even this individual contributor is complicated because it is not merely a single beetle species that is responsible. Exotic wood boring beetles tend to have few natural enemies and therefore, their populations are poorly regulated and grow at a much faster rate than in their native range. When beetle populations are high, healthy trees are more prone to being attacked by pests that may otherwise only attack unhealthy trees. The state administers numerous quarantines (see last section) which are meant to prevent the importation of exotic wood-boring pests into the state. Quarantines are the "first line" of defense against harmful exotic insects. Trapping programs are another defensive strategy and are essential for preventing the decline of forest health. When trapping detects exotic insects early, their populations can be eradicated or, if eradication isn't possible, advanced knowledge of their presence can give landscape or crop managers time to develop effective suppression strategies.

The Utah Department of Agriculture and Food (UDAF) Insect Program monitors for several exotic wood-boring beetle species, all of which fall into one of three large beetle families. The bark and ambrosia beetles (family Curculionidae subfamily Scolytinae) are diminutive beetles that mine the inner bark of woody material in their adult and larval stages. Longhorned beetles (Cerambycidae) and jewel beetles (Buprestidae) can range in size from half a centimeter to upwards of several centimeters, with a great variety of colors and habits. The larval stages of these families feed on the conductive tissues of trees inside trunks and branches. Eventually, the adults emerge from the tree and repeat the life cycle.

State Wood-Borer Targets



Emerald ash borer

Popularly known as "The Green Menace" emerald ash borer (EAB) *Agrilus planipennis* (Fairmaire) has lived up to its nickname by decimating all species of ash trees *Fraxinus spp.* in the United States (U.S.) since its first detection in Michigan in 2002. Although small (25 mm in length), it should not be underestimated. In the last two decades EAB has spread to 30 states and destroyed tens of millions of ash trees. The pest is established in many Eastern, Southern and Midwestern states. The beetle came even closer to Utah when it was found in the neighboring state of Colorado in 2013. It is now found in four counties east of the Colorado Front Range.

In recent years, the UDAF Insect Program has been preparing for EAB introduction by forming a task force of partner agencies and groups, including the United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS), USDA Forest Service, Utah State University (USU) Pest Diagnostics Laboratory, Utah Department of Natural Resources (DNR), Tree Utah, and city arborists. This coalition has embarked on a multifaceted campaign to prevent introduction and facilitate early detection. Efforts include deploying EAB traps statewide, educating the public about the dangers of moving firewood, and outreach to local tree care professionals on EAB identification. In areas of the state deemed high-risk for introduction, state, federal and local officials have been involved in trapping, visual surveys, and caged rearing of ash limbs that are suspected to be infested. The UDAF Insect Program and others have also responded to dozens of EAB infestation claims by homeowners and landscape managers. To date, there have been no confirmed cases of EAB in Utah.

As the pest has continued spreading to other states, there have been considerable strains on federal funding dedicated to containment. In 2017, USDA-APHIS announced that it was removing its domestic EAB quarantine. Consequently, federal funds directed toward trapping would be reallocated to biocontrol and research. As a result of this announcement, the Utah task force stepped up efforts to exclude and monitor for this pest. Utah DNR applied for a USDA Forest Service grant to fund increased trapping efforts; some of this money was passed to UDAF for improved surveillance and outreach efforts.

In 2021, the UDAF Insect Program placed a total of 72 EAB traps throughout Cache, Carbon, Davis, Duchesne, Salt Lake, Tooele, Uintah, Utah, and Weber counties. Utah DNR placed an additional 29 traps across Emery, Grand, Iron, Juab, Millard, San Juan, Sevier, Washington, and Wayne counties. Trap site placement was prioritized for high-risk areas such as: places that were likely to have out-of-state firewood introduced, vicinities where trees have been reported as potentially infested by arborists or homeowners, and neighborhoods identified as having numerous ash trees in decline. In 2022 the UDAF Insect Program will continue leading task force efforts such as regulatory measures, trapping, visual survey, and outreach efforts.

Pine shoot beetle

Pine shoot beetle (PSB) *Tomicus piniperda* Linnaeus is an invasive bark beetle with a large native range in Eurasia and North Africa that was first detected in the U.S. in 1992. Since its introduction, the pine shoot beetle has spread throughout much of the Northeast and Midwest. Most damage is caused by adults feeding inside young shoots of healthy pine trees. Utah maintains a quarantine of this insect because of its ability to kill healthy trees and due to its pest status in its native range. In 2021, 25 traps were placed in eight Wasatch Front counties, with no detections. PSB has never been detected in Utah.

Cooperative Agricultural Pest Survey

USDA APHIS coordinates the Cooperative Agricultural Pest Survey (CAPS), a science-based federal and state collaborative effort to detect exotic organisms that threaten national agriculture and/or the environment. Every year the program allocates money to participating states to place traps for high-priority target pests. Utah annually participates in the CAPS wood-borer survey and in 2021, 77 traps were placed within eight Northern Utah counties in riparian corridors and municipal parks to target several different pests. With the exception of the velvet longhorned beetle *Trichoferus campestris* (Faldermann) and a single specimen of *Orthotomicus erosus* (Wollaston) (see below), none of these target pests have yet been detected in Utah.

CAPS Wood Borer Targets

Black fir sawyer & Japanese pine sawyer

Monochamus is a genus of large longhorn beetles that are widely distributed throughout the world, including several native species found in Utah. Most species host primarily on coniferous trees. Black fir sawyer *Monochamus urussovii* (Fischer-Waldheim) is native to spruce *Picea spp.* and fir *Abies spp.* forests from Finland to Japan, and is considered a serious pest in Siberia. Japanese pine sawyer *Monochamus alternatus* (Hope) is indigenous to China, Korea, Laos and Japan. Both of these beetles can vector pathogenic nematodes to healthy trees which causes large annual losses in forests and plantations in Asian and European counties. Neither species are known to be established in the U.S., though *M. alternatus* was intercepted once in a New York warehouse in the 1990s.

Large pine weevil

Hylobius abietis (Linnaeus) is a commercially important pine plantation pest in Europe and Asia and causes millions of dollars in damage annually. The beetle's larval stage does not cause significant damage to living trees as eggs are laid in recently cut tree stumps, but adult weevils feed on a large variety of coniferous and some deciduous seedlings. Plantations will often have complete loss of new transplants without pesticide treatments. This pest is not established in North America but has been intercepted at ports of entry and in the mail.

Mediterranean pine engraver

Mediterranean pine engraver *Orthotomicus erosus* (Willaston) is a bark beetle native to southern Europe, Asia, and northern Africa. This beetle has a large primary host range of pine *Pinus spp.* species, but can attack other coniferous trees such as spruce, cedar *Cedrus spp.*, and fir. It normally will feed and oviposit on dead or dying trees, however, pine populations in *O. erosus's* native range have seen significant outbreaks of the beetle in recent years as long-term drought conditions place stress on forests.

Populations of this beetle were found in California in 2004 and it has become established in the central valley of the state. In 2015 it was first detected in Nevada, and as of 2020 Utah had its first confirmed detection of *O. erosus*. As with many woodboring beetles, it was likely transported east via firewood. It is unknown how widespread it has become in Utah at this point. More traps will be placed where the single specimen was found as trapping continues into 2022. Preliminary identification for the 2021 trapping season has not detected any more *O. erosus* specimens.

European spruce bark beetle & six-toothed Ips

Ips bark beetles are moderate to large bark beetles (up to 1/3 of an inch) that feed on coniferous trees. European spruce bark beetle *Ips typographus* (Linnaeus) specializes in spruce trees and is native to Europe, where Norway spruce *P. abies* is naturally found. Six-toothed Ips *Ips sexdentatus* (Boerner) has a larger host list of coniferous trees and is native to Eurasia. Both are normally considered secondary pests of dead or weak trees, but stressors such as fire, drought, or windstorms will cause large outbreaks. They also transmit blue-stain fungi (various genera), which are pathogens associated with higher tree mortality. Six-toothed Ips has been intercepted 157 times in the U.S. at various ports, while positive identifications of European spruce bark beetle were made twice in Indiana and Maryland during surveys. Subsequent trapping in both of these areas did not find further specimens.

Velvet longhorned beetle

Velvet longhorned beetle (VLB) *Trichoferus campestris* was detected in South Salt Lake City in 2010. In subsequent years, hundreds of VLB would be found near this area and in multiple Utah County commercial fruit orchards. This was distressing because VLB was known to attack live apple *Malus spp.* trees in its native range. The state was not in a good position to deal with this pest after detection because there was not a proven trap or lure methodology for capturing the pest, nor was there a treatment protocol. Eradicating insects is much easier if there is a reliable and cost-effective way to determine the extent of the infestation, a clear method to eliminate the pest, and the population is detected quickly after introduction. Utah possessed none of these advantages.

Just a few years after early detection the prospect of eliminating VLB from Utah dimmed. However, an opportunity to learn more about this insect and perhaps prevent it from spreading to other

states presented itself. Upon learning of the Utah infestation, scientists from the USDA Center for Plant Health Science and Technology (CPHST) Otis Laboratory and Xavier University became interested in conducting scientific research of VLB in the state. They were especially interested in developing a trap and lure methodology and determining what other valuable host trees VLB might attack, aside from those already known. The UDAF Insect Program agreed to assist CPHST with these endeavors and by mid-decade, a number of scientific projects began.

After many years of research, these scientists identified a male-produced aggregation pheromone and created a synthetic analog, which could be used as an attraction lure for cross vane panel traps. This trapping method is currently in use around the country for survey purposes. Scientists also identified several new plant hosts that VLB attacks, such as peach *Prunus* spp. and cherry *Prunus spp*.

While these scientific projects were happening, the UDAF Insect Program began surveying multiple counties in the state with the new trap and lure methodology to determine where VLB had spread. It was eventually learned that the beetle was present in Box Elder, Davis, Salt Lake, Summit, Tooele, Utah and Weber counties.

After more than a decade of working on VLB-related projects, the state is now considered "generally infested." USDA APHIS has dropped VLB from its National Pest Priority list and, therefore, UDAF will no longer be trapping the pest as part of the CAPS Wood Borer Survey in future years.

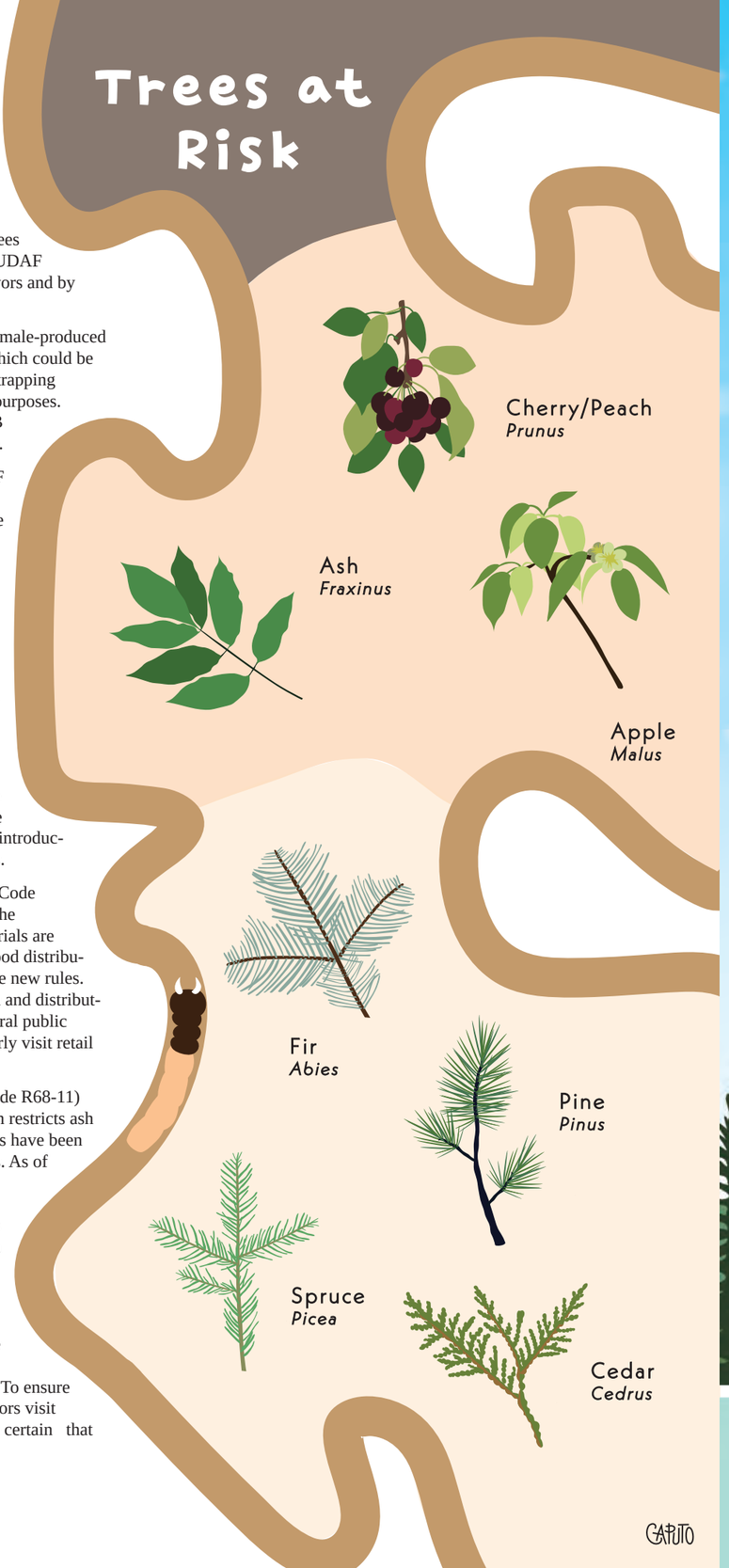
Firewood and Nursery Stock Quarantines

Firewood and nursery stock movement are considered the highest risk pathways for wood-boring beetles to enter the state, so regulating their movement is critical in reducing introduction risk. Thus, the state enforces a number of quarantines.

The Utah Firewood Quarantine (see Utah Administrative Code R68-23), which was enacted in 2017. This rule prohibits the importation of firewood from other states unless the materials are certified to be free of plant pests. Both commercial firewood distributors and members of the general public are subject to these new rules. The UDAF Insect Program has conducted media outreach and distributed literature to educate firewood distributors and the general public about these rules. State agricultural inspectors also regularly visit retail locations that sell firewood, to ensure compliance.

In 2021, an EAB Quarantine (see Utah Administrative Code R68-11) went into effect (see News and Notes on page five), which restricts ash nursery stock and other related articles. Nursery inspectors have been informing Utah's greenhouse growers about the new rules. As of this publishing, there are no states that have filed for an exemption, which would allow ash importation. UDAF is currently in communication with a few neighboring states that are thought to be uninfested and may qualify for such an exemption. However, until an exemption is filed and approved by a qualifying state, the importation of an ash into Utah is currently prohibited.

Since 1992, Utah has administered a PSB Quarantine (see Utah Administrative Code R68-16). Quarantined articles include Christmas trees and firewood of various conifers. To ensure compliance with this quarantine, state agricultural inspectors visit Christmas tree lots every winter to inspect trees and make certain that stock is from non-quarantined areas.



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Bottom Row: (left to right) Sarah Schulthies – Lab Technician, Jenna Crowder – Diagnostic Entomologist & Honey Bee Inspector

Not Pictured: Gabriel Brown – EAB & EWB Trapper, Tim Graham – JB/GM Trapper, AHB Surveyor

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Apiary Resources

UDAF Apiary Program
ag.utah.gov/farmers/plant-industry/apiary-inspection-and-beekeeping
USDA-ARS Pollinating Insect-Biology, Management, Systematics Research
ars.usda.gov/pacific-west-area/logan-ut/pollinating-insect-biology-management-systematics-research
Project Apis m.
projectapism.org
Apiary Inspectors of America
apiaryinspectors.org

Invasive Insect Resources

UDAF Invasive Insect Program
ag.utah.gov/farmers/plants-industry
Japanese Beetle Eradication
ag.utah.gov/jberadication
USDA-APHIS-PPQ
aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases
Utah Cooperative Agricultural Pest Survey Program
utahpests.usu.edu/caps/utah-caps-program
Utah Plant Pests Diagnostic Laboratory
utahpests.usu.edu/uppdl
National Plant Board
nationalplantboard.org

Trade Associations

Utah Nursery and Landscape Association
utahgreen.org
Utah Horticulture Association
extension.usu.edu/productionhort/fruit/tree/untitled
Utah Beekeepers Association
uba.wildapricot.org

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