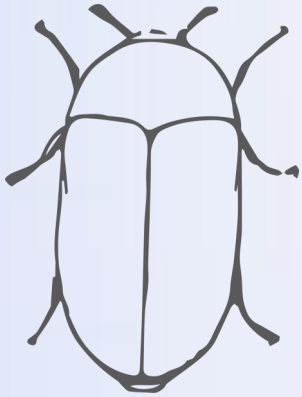


2019 Insect Report

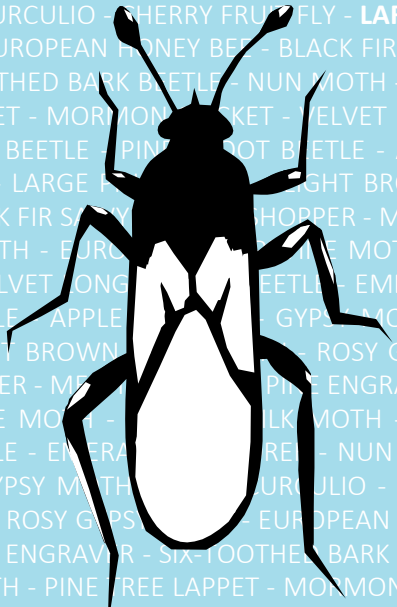
UTAH DEPARTMENT OF AGRICULTURE AND FOOD

DIVISION OF PLANT INDUSTRY

LARGE PINE WEEVIL

Hylobius abietis (Linnaeus)

2019 Insect Report



UTAH DEPARTMENT OF AGRICULTURE AND FOOD

JANUARY 2020

PROGRAM PARTNERS

USDA CENTER FOR PLANT HEALTH SCIENCE AND TECHNOLOGY

UTAH STATE HORTICULTURE ASSOCIATION

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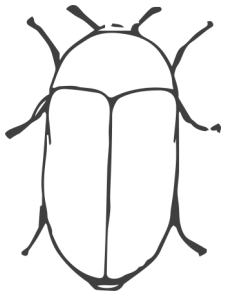


FEATURED ARTICLES

Message from the Manager

State Entomologist Kristopher Watson discusses how the UDAF Insect Program protects agriculture and improves Utah's quality of life.

On behalf of the Utah Department of Agriculture and Food (UDAF) Plant Industry's Insect Program, thank you to all the farmers, ranchers and constituents of the great state of Utah that support and protect our agricultural and natural resources from new invasive and endemic agriculture pests. UDAF has been addressing insect issues since pioneer agriculture began in Utah over 160 years ago. With your support, we have managed to find small populations of new invasive pests, such as Japanese beetle (JB) and gypsy moth (GM), and prevent their establishment before they could impact our state for generations to come. The importance of early detection and rapid response is critical to the success of future projects and the viability of agriculture. UDAF has been delegated the extremely difficult task of controlling and eradicating pests that threaten our natural resources and food supply. Invasive pests and diseases are moving around the world at an alarming rate, due to the growth of commerce and world-wide trade. These developments have created new pathways for pest introduction unlike anything before.

Additional changes in monoculture farming, weather patterns and climate all contribute to agricultural losses and threaten our resource needs. Agricultural pests have the potential to impact U.S food crops much like a natural disaster, with annual losses estimated to be between 20-25% depending on host and species. While many insects are beneficial and we support pollinators, invasive pest infestations can be devastating to agriculture as well as our environment.

In 2019, UDAF identified JB at multiple locations in Salt Lake and Davis counties. In response to these detections, our staff placed more traps than ever to determine the extent of infestation. Without leaving behind other pest priorities and obligations, the JB populations detected will be our number one focus in 2020. We have had success eradicating this pest before; in fact UDAF conducted the largest eradication program in the nation with over 2,000 beetles captured in the city of Orem in 2007. After years of diligent eradication efforts, which included communication, treatment, quarantine and surveillance, UDAF declared success during the fall of 2014. With less than 50 beetles captured in 2019, we are optimistic that with the same attentiveness, effort and support, Utah will remain free of this destructive pest for years to come.

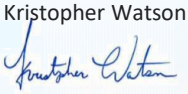
It may go without saying that JB detections were our most disturbing discovery this year. However our program has been extremely busy with other priorities as well.

- ◊ After nearly a decade of research and development on the recently introduced pest velvet longhorned beetle (VLB), UDAF has helped create an effective trap and lure method. This trap is now being used by other states to monitor for VLB.
- ◊ Extensive trapping was conducted for GM, European corn borer, orchard pests and exotic wood borers. No new target pests were found!
- ◊ Our Apiary Program continues its efforts in American foulbrood and parasite suppression. This spring we sent out a "statewide pest alert" reminding beekeepers of the threat of Varroa mite and the importance of treating for them. We will continue providing inspections and information to our registered beekeepers, so don't forget to register your bees every year. Also, please thank a county bee inspector for their efforts, as they are critical in making this program a success.

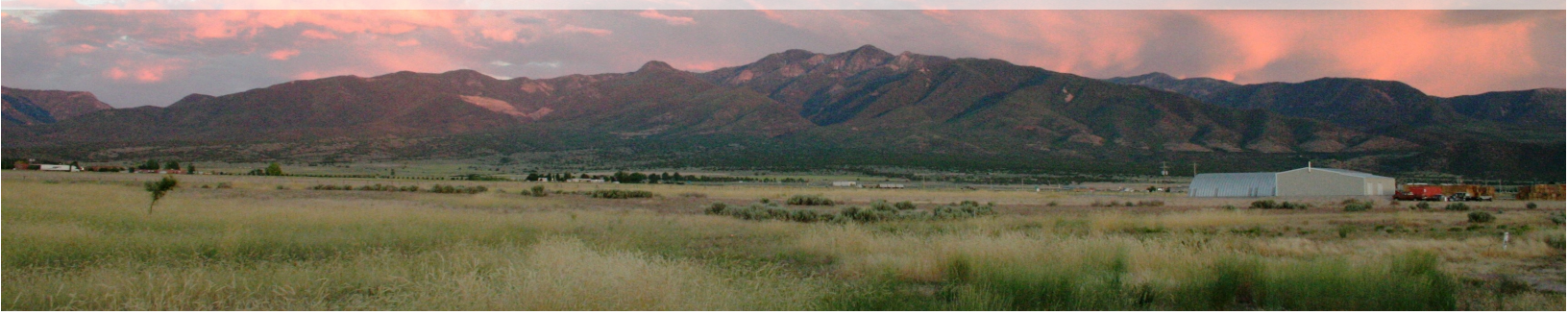
I cannot thank our staff enough as they continue to work hard to protect, monitor and control invasive pests and diseases in an effort to maintain a competitive market, minimize losses and protect the future of agriculture in the state. As we are challenged by new invasive pests moving forward, I give you my commitment, as well as that of the Insect Program staff, to do our absolute best to safeguard the social, environmental and economic integrity of the state of Utah. With your help, we will continue to protect the state's agricultural industries, food supply and our quality of life from endemic and invasive species for years to come.

It comes with my deepest respect, in which I say, thank you!

Kristopher Watson



State Entomologist



AT A GLANCE ACCOMPLISHMENTS

23	COST SHARE AGREEMENTS TO SUPPRESS	RANGELAND PESTS	Disruptors of Utah's $715 million small grain and field crop industry.
51	TRAPS PLACED TO DETECT	EMERALD ASH BORER	Serious threat to all ornamental and native ash species in Utah.
75	TRAPS PLACED TO DETECT	ORCHARD PESTS	Invasive and endemic pests of the state's $34 million fruit industry.
85	TRAPS PLACED TO DETECT	EUROPEAN CORN BORER	Introduction could increase control costs for the state's corn industry.
108	TRAPS PLACED TO DETECT	WOOD BORING BEETLES	Potential threat to state's urban and natural forests.
490	TRAPS PLACED TO DETECT	DEFOLIATING MOTHS	Introduction could cause forest disruptions and damage to watersheds.
1,514	HIVES INSPECTED TO DETECT	HONEY BEE PESTS AND DISEASES	Reduces colony productivity and increases colony losses.
2,160	TRAPS PLACED TO DETECT	EUROPEAN GYPSY MOTH	Pest of urban forest canopies and potential threat to water quality.
3,248	TRAPS PLACED TO DETECT	JAPANESE BEETLE	Severe pest of the state's fruit, vegetable and ornamental plant industries.

THE UTAH APIARY PROGRAM

STATE AND COUNTY GOVERNMENTS
HAVE WORKED TOGETHER FOR
OVER 125 YEARS TO PROTECT
HONEY BEE HEALTH.

TODAY'S PROGRAM TAKES A
21ST CENTURY APPROACH TO
HELPING BEES.

For more than 125 years the state of Utah has cooperated with county governments to protect the health of honey bees *Apis mellifera* (Linnaeus) through inspection of managed operations. Identifying the numerous diseases, parasites and other maladies that affect Utah's honey bee colonies is just as important now as it was over a century ago when the program began. Today's cooperative Apiary Program is led by the Utah Department of Agriculture and Food (UDAF). The statute which guides the program allows county governments to appoint an inspector upon the petition of five beekeepers; it permits the state to hire inspectors as well. These coordinated efforts help safeguard the approximately 37,000 beehives that call Utah home and protect an industry estimated to be worth between $20-30 million annually.

Inspection Results

Both state and county inspectors had a productive year in 2019. State inspectors examined 1,514 individual hives in approximately 150 operations. County inspectors looked at another 42 apiaries which had 462 hives. The rate of American foulbrood (AFB) *Paenibacillus larvae*, the most deadly and contagious of brood diseases, was found in only 1.3% of hives inspected. This was encouraging because in 2018 3.9% of hives inspected had AFB, a rate substantially higher than the Apiary Program's goal of keeping the disease's prevalence below 1% of colonies. The reduced rate in 2019 demonstrated the effectiveness of increased inspection efforts in response to outbreaks in the previous year. Recent beekeepers outreach by UDAF on how to acquire antibiotics under new federal rules (see page 6) likely

"The reduced rate [of American foulbrood] in 2019 demonstrated the effectiveness of increased inspection efforts in response to outbreaks."

reduced the rate of AFB incidence as well. Unfortunately, there was a sharp rise in European foulbrood (EFB) *Melissococcus plutonius* disease in 2019 (6.1%) compared to the previous year (4.4%). EFB is a less serious disease than AFB, but the elevated rate is nonetheless worrisome and will continue to be a concern in 2020. Varroa mite *Varroa destructor* (Anderson and Trueman), the most devastating honey bee parasite, and a condition associated with this pest known as parasitic mite syndrome (PMS) were overall down compared to last year. This was likely due to a UDAF Apiary Program-organized outreach effort prior to peak Varroa mite population growth (see "Varroa Outreach Efforts" below). The fungal brood pathogen chalkbrood *Ascosphaera apis* was found in 4.6% of hives inspected. Many of these cases were detected in the summer months, which is counter to the disease's reputation as a primarily cool season, spring-time concern. Finally, just two operations were found infested with the invasive bee pest small hive beetle (SHB) *Aethina tuminda* (Murray). SHB was recently introduced to Utah; populations have been confirmed in Davis, Millard and Washington counties. Due in large part to Utah's dry climate, SHB is unlikely to be a major problem for Utah beekeepers, as the pest thrives in humid environments. However, individual beekeepers may experience occasional outbreaks and vigilance is needed to avoid economic impact. Therefore, the UDAF Apiary Program will continue to track future distribution and prevalence.

Varroa Outreach Efforts

In response to excessive Varroa mite infestations documented during late summer and fall months over the past five years, the UDAF Apiary Program sent a postcard to all registered beekeepers to remind them of the importance of monitoring and controlling this devastating pest. The postcard was sent out in early August to align with the beginning of peak mite season in Utah. State inspectors also worked with beekeeping clubs and county inspectors to ensure that a consistent message was getting out to apiarists on various channels. This approach appeared to be tremendously effective in reducing Varroa mite infestations in the late summer months. Yet mite

populations spiked later in the season, indicating that, in some cases, beekeepers failed to continue monitoring and implementing control measures into the fall months. In 2020, the UDAF Apiary Program will refine educational efforts regarding the importance of controlling these pests during late summer and fall.

The National Honey Bee Survey

The United States Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS) began the National Honey Bee Survey (NHBS) in 2009 to address the well-documented problems with overall honey bee health. 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 exotic Asian honey bee *Apis cerana* (Fabricius) and pesticide residues in beeswax.

Although it is a federal program, money is allocated to participating states to conduct sampling and data collection. Sampling involves collection of adult bees, immature bees and wax from operations that have 10 or more hives. These are sent to the USDA Bee Research Laboratory in Beltsville, Maryland where they are tested for exotic pests, pathogens and pesticide residues. The UDAF Apiary Program and beekeepers throughout the state have participated in NHBS since 2011 and have contributed hundreds of samples to this important body of scientific data.

To date, no exotic pests or pathogens have been detected in Utah. Data collected thus far have demonstrated that Varroa mite infestations are, on average, in excess of levels thought by scientific authorities to be acceptable from the months of August through October (mirroring state data). Multiple years of wax testing suggests that pesticide residues in Utah's beehives are frequently below the national average. In 2019 state inspectors completed 24 NHBS samplings statewide. The complete results of this survey can be viewed at the Bee Informed Partnership website: https://bip2.beeinformed.org/state_reports/

Africanized Honey Bee

Since 2008 when Africanized honey bee (AHB) *Apis mellifera scutellata* (Lepeletier) was first detected in Southern Utah the UDAF Apiary Program has monitored its spread through the state. Though AHB can be dangerous, they have been unfairly sensationalized in the media. Thankfully, education efforts have successfully decreased panic and stinging incidents nationwide. In Utah, there have only been a few instances of AHB attacking humans or animals. 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.

"State inspectors continue to track [Africanized honey bee]...to new areas by testing feral bees and aggressive managed colonies in non-infested 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 in non-infested counties. The UDAF Apiary Program is committed to ensuring that all stakeholders are made aware whenever AHB moves into a new county. No new county records were found in 2019. Looking forward to next year, detection efforts will again be focused on counties at highest risk for introduction.

Protecting Bees from Pesticide Misuse

In response to high-profile concerns about pesticide misuse and the potential 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 planting pollinator-friendly flora. This is accomplished via public presentations, one-on-one trainings and the distribution of educational literature. UDAF will review and update this plan in 2020. Since its implementation the state has undertaken extensive education and outreach efforts; 2019 accomplishments include:

Education of pesticide applicators

The UDAF Apiary Program participating in three outreach events to educate pesticide applicators, including:

- ◊ Utah Nursery and Landscape Association Green Industry Conference – Hundreds of attendees stopped by an outreach booth, where they learned of best practices for pesticide applications.
- ◊ Utah Pest Control and Lawn Care Association Conference – Meeting goers were given a presentation on how to find and follow specific pesticide label requirements to protect bees, as well as optional practices that are above and beyond what is required by law.
- ◊ Millcreek Garden's employee training – Staff of this local retail nursery participated in a question and answer discussion relating to pollinator and beneficial insect protection.

Training for pesticide compliance officials

When there are credible reports of unlawful pesticide exposure to honey bee colonies, these incidents are reported to the UDAF Pesticide Program (ag.utah.gov/farmers/plants-industry/pesticides), which is responsible for state and federal pesticide use compliance. The officials working in this program are highly trained and have a thorough understanding of pesticide regulations. However, in some cases these individuals may have limited experience working with bees. In the past, the UDAF Pesticide Program often addressed this knowledge gap by having a bee inspector present during pesticide investigations to provide technical expertise. While this cooperative practice is likely to continue in the future, the Apiary Program and Pesticide Program collaborated to improve the knowledge and hands-on experience of pesticide investigators with a practical training. Topics reviewed included basic honey bee biology, inspection procedures and signs and symptoms of hives exposed to deleterious chemicals. This was followed by a hands-on workshop, where pesticide compliance staff were able to work with live honey bees. The training followed the Environmental Protection Agency's (EPA) "Guidance for Inspecting

Beekeepers listen to Dr. Joseph Wilson (far left) talk about honey and native bee biology at the 4th annual Utah Honey Bee Conference, at Utah State University Tooele. The conference was organized by the Utah Department of Agriculture and Food Apiary Program.

Alleged Cases of Pesticide-Related Bee Incidents" document for investigating suspected pesticide poisonings of bees.

Education of beekeepers

State inspectors also took opportunities throughout the year to educate beekeepers about the potential dangers of off-label pesticide applications to their own colonies. Pesticide applications, in the form of miticides, are critical tools used by beekeepers to control Varroa mite infestations in their hives. There are numerous EPA-approved miticides which beekeepers can safely use to keep parasites at bay and maintain healthy colonies. However, off-label pesticide applications are sometimes made to reduce cost or for convenience. While this purportedly "saves" money and time, it often comes at the expense of bee health. Bees can suffer inadvertent harm by off-label miticide use because these methods potentially contain too much active ingredient, release the active ingredient too quickly or result in ineffective parasite control. At the annual Utah Beekeepers Association convention and the Utah Honey Bee Health Conference (see page 7), inspectors discouraged beekeepers from off-label applications and conducted workshops on how to properly apply EPA-approved miticides per label.

Other outreach

The UDAF Apiary Program promoted pesticide use best practices at the retail-sales level. This was accomplished by the placement of educational displays at pesticide retailers around Utah which outlined three simple steps applicators can take to prevent pesticide exposure to bees. Participating retailers included Intermountain Farmer's Association (IFA), Tractor Supply Co., Oasis Seed Company and Home Depot.

Finally, the program participated in the annual SLC Bee Fest, hosted by Catalyst Magazine. State inspectors tabled at the event to educate attendees about the importance of planting flowers which serve as nutrition sources to bees. The UDAF Apiary Program distributed hundreds of pollinator-friendly seed packets to attendees and encouraged their planting.

Honey Bees and Antibiotics

As a response to the growing threat of antibiotic-resistant strains of pathogens, the United States 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 two years this change has significantly impacted beekeepers by restricting their access to antibiotics and prohibiting prophylactic use. Perhaps the most substantial requirement of the VFD is that

Tens of thousands of Utah's honey bee colonies are sent to other parts of the country each year to pollinate crops and produce honey. In 2019, the Apiary Program provided health certification of 11,185 colonies to meet import requirements of other states; 1,185 hives were certified for in-state sales.

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 factor contributing to Utah's higher rates of AFB and EFB 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 quantitative polymerase chain reaction (qPCR) disease diagnostic capabilities to the UDAF Entomology Lab (see page 14) in 2018 was critical in the success of this effort; now Utah's veterinarians and beekeepers can expect accurate test results in as quickly as 24 hours. The previous practice was to send samples to out-of-state labs, which sometimes took weeks to deliver results.

Honey Bee Health Conference

The annual Utah Honey Bee Health Conference was hosted during November in Tooele and was a great success. Most of the beekeepers that were present lived in Tooele County or along the Wasatch Front, though some made a trek from other areas of the state to attend. The program began with an update on honey bee health in Utah from state and county inspectors. This was followed by a presentation from Dr. Joseph Wilson, Utah State University Associate Professor of Biology, and author of "The Bees in Your Backyard: A Guide to North America's Bees." The presentation covered the evolution of bees, what makes a "bee" and steps homeowners and beekeepers can take to help Utah's pollinators. After the presentations, beekeepers were given the opportunity to attend breakout sessions that covered foulbrood detection, Varroa mite measurement, proper miticide applications, and SHB identification.

Health Certification

The UDAF Apiary Program offers health certification services to registered beekeepers in the state. Many states require that imported colonies be inspected and certified free of certain pathogens or pests prior to arrival. Depending on requirements of other states, certificates may be requested that confirm hives are free of AFB, SHB or the federally-regulated human and livestock pest red imported fire ant *Solenopsis invicta* (Buren). Also, retailers that sell honey bees within the state will often request a health certificate so that customers can be assured they are free of disease. In 2019, state inspectors certified 11,185 hives to meet the import requirements of other states; 1,115 hives were certified free of disease for in-state sales.

The Orchard Sentinel Survey

The Insect Program monitors for invasive and native pests in Utah's multi-million dollar fruit industry.

The Utah Department of Agriculture and Food (UDAF) Insect Program's orchard sentinel survey is an assemblage of five different insect traps placed at 15 fruit growing sites along the Wasatch Front. 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 nearly a decade. The purpose of the survey is threefold:

- ◊ Provide early detection of invasive fruit pests not known to be in Utah.
- ◊ Track movement of pests that are present in certain fruit growing counties but not others.
- ◊ Inform growers of the presence and prevalence of native or established exotic 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 pests and good data regarding the presence of native or established exotic pests is 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.); its first detection in the West occurred in 1979 in Oregon. It was later detected in Utah in 1985. It is likely that the introduction 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 not infested. 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 insect and ensure that it does not become a severe problem for professional fruit growers. In 2019, no apple maggots were detected at any trapping sites.

European grapevine moth *Lobesia botrana* (Denis & Schiffermülleris) is a serious pest throughout Europe, West Africa, the Middle East and eastern Russia. As the name suggests, it attacks grapes *Vitis* spp. but also can feed on blackberry *Rubus* spp., sweet cherry *Prunus* spp. and other important plants. A population of these moths was identified in California in 2009. The United States Department of Agriculture Animal Plant Health Inspection Service, with cooperation of the state, eradicated the pest and therefore it is no longer known to be in the U.S. However the UDAF Insect Program continues to monitor for this invasive insect, as reintroduction to the country is a constant concern.

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 in anywhere else in the state. Utah is the only part of western North America with known population of plum curculio. The UDAF Insect Program surveys for plum curculio in non-infested areas, such as Davis and Utah counties to ensure the pest is not spreading. In 2019 no plum curculio were detected in any 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 first found in the mainland of the U.S. in California in 2007. Today 13 counties in California are under quarantine to prevent its spread. To ensure that the pest is not 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 industry. Western cherry fruit flies are captured on the same traps that are placed for detection of apple maggot. UDAF Insect Program entomologists examine these traps on 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. 2019 trapping detected 953 specimens at six locations.

Orchard sentinel survey target pests — Apple maggot *Rhagoletis pomella*, European grapevine moth *Lobesia botrana*, Cherry fruit fly *Rhagoletis indifferens*, Light brown apple moth *Epiphyas postvittana*, plum curculio *Contrachelus nenuphar*

Japanese beetle

Eradication of the invasive beetle was declared in Utah over five years ago. In 2019, new populations were detected in two counties. State agricultural officials are determined to vanquish the pest once again.

strikes back

SPECIAL REPORT

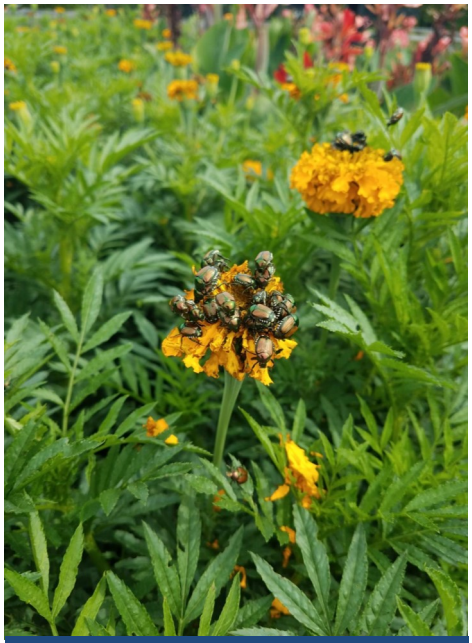
For more than 100 years federal and state agricultural authorities have battled the devastating invasive pest Japanese beetle (JB) *Popillia japonica* (Newman). In its native Japan, JB is not known to be a serious pest; this is likely due to host-plant resistance and numerous natural enemies that keep their populations in check. In the United States (U.S.) it has been a different story. In spring months, the larval (grub) stage feeds on the roots of grass and is a severe turf pest. The beetle pupates under the soil in late spring and emerges as an adult in early summer. Adults have a voracious appetite and can feed on the foliage of over 300 host plants, including many popular and economically important fruit, vegetable and ornamental plants. It is estimated that infested states spend approximately $460 million annually to control the pest and to replace damaged host plants.

JB history in the U.S.

JB was first detected in the U.S. at a nursery in New Jersey in 1916. The state government put together a plan to eliminate the pest, however the program was severely underfunded and the nursery that imported the pest wouldn't fully cooperate with the effort. The beetle quickly spread throughout other New England and Mid-Atlantic states. By the end of the 1950s the pest was sporadically appearing in many Midwest and Southern states.

While the outlook for containment may have appeared dim at that time, it became recognized by entomologists that small, isolated populations of JB (that did not border widely infested areas) could be eliminated. In subsequent decades, the state of California demonstrated this multiple times by eradicating three separate JB populations within the state. Other states and local governments would follow in eradicating small populations as well. These successes proved that with early detection of the pest and swift response, non-infested states could maintain their JB-free status even with occasional introductions.

Today only 12 states (including Utah) are considered to be non-infested. Most of these states are west of the Rocky Mountains. Key to keeping these areas JB-free are quarantine measures which restrict the importation of commodities that may harbor JB (e.g. nursery stock, turf and soil) and annual trapping to detect populations quickly if they are introduced. In recent years, Idaho and Oregon have both detected sizable populations of JB and are taking aggressive eradication actions to maintain their JB-free status. Idaho has all but eliminated their infestation and Oregon continues to make substantial progress.



JB devouring marigolds at a botanical garden in Iowa.

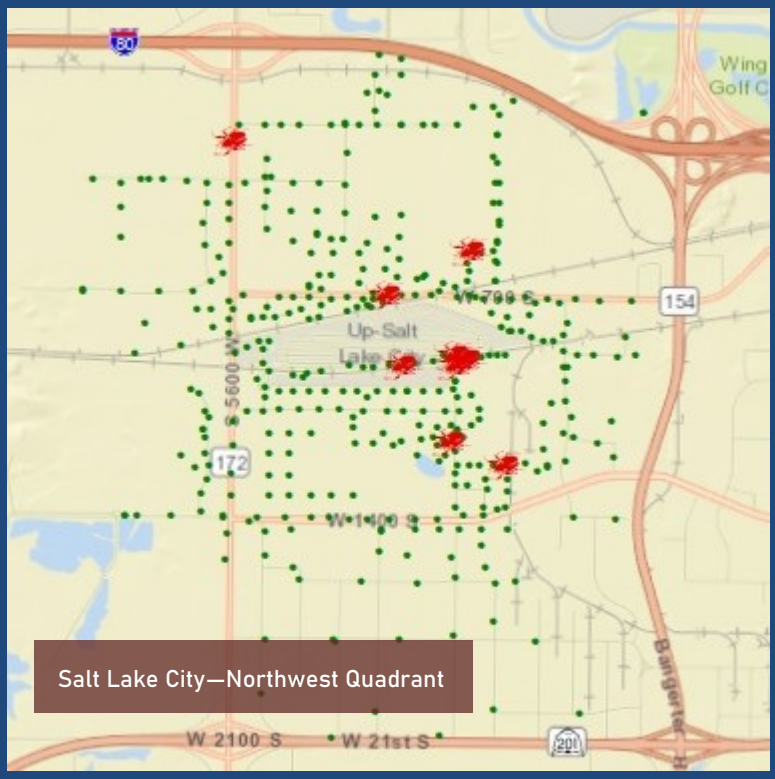
JB history in Utah

Utah has long maintained JB-free status. It should be stressed however, that this is no coincidence or matter of luck. The state's campaign to keep JB out began in 1993 when UDAF enacted a quarantine (Utah Administrative Code R68-15) of high-risk commodities from infested states. This meant that Utah would begin requiring out-of-state nurseries and turf growers, in infested areas, to comply with precautionary measures before importing products that might serve as a pathway for JB introduction. Just three years later the UDAF Insect Program began an annual trapping program to identify any nascent JB populations; for a decade, no beetles were detected.

However, in 2006 an Orem resident found a single JB at her home garden. She reported the finding to the Utah Department of Agriculture and Food (UDAF) Insect Program, which set in motion an extensive trapping effort to determine the extent of infestation. About 100 traps were deployed in the neighborhood and a total of 675 JB would be found in that year alone. The next year would prove worse, with over 2,000 beetles detected in a single season. The infestation area measured approximately 100 square residential blocks.

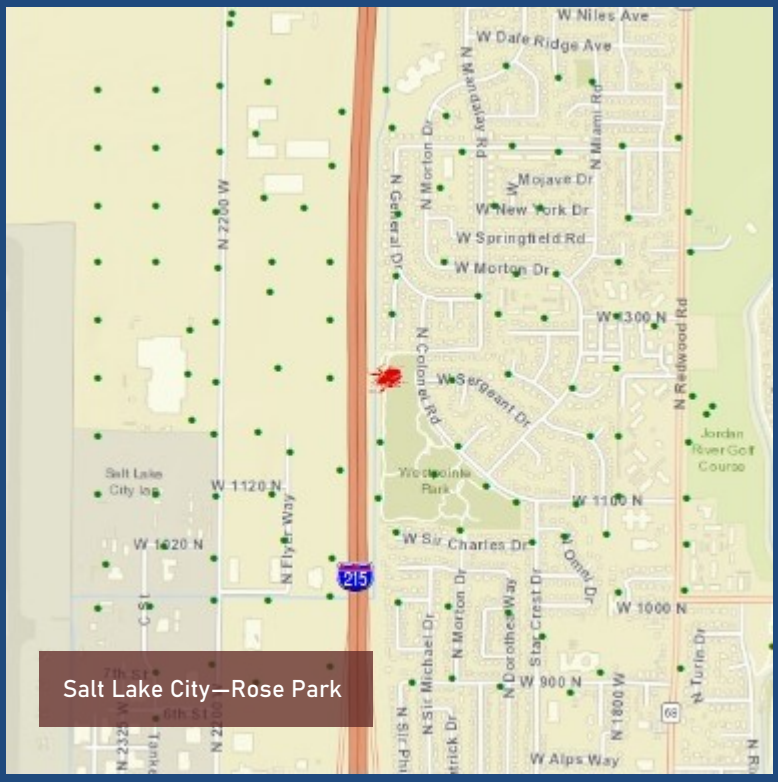
While other states had eradicated JB before this time, eradication of an infestation this large had never been attempted elsewhere in the country. Nonetheless UDAF, in cooperation with the city of Orem, decided to embark on an unprecedented effort to rid the state of this scourge. Intensive pesticide treatments of turf and other host plants followed in subsequent years. As a result, 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.

2019 DETECTION

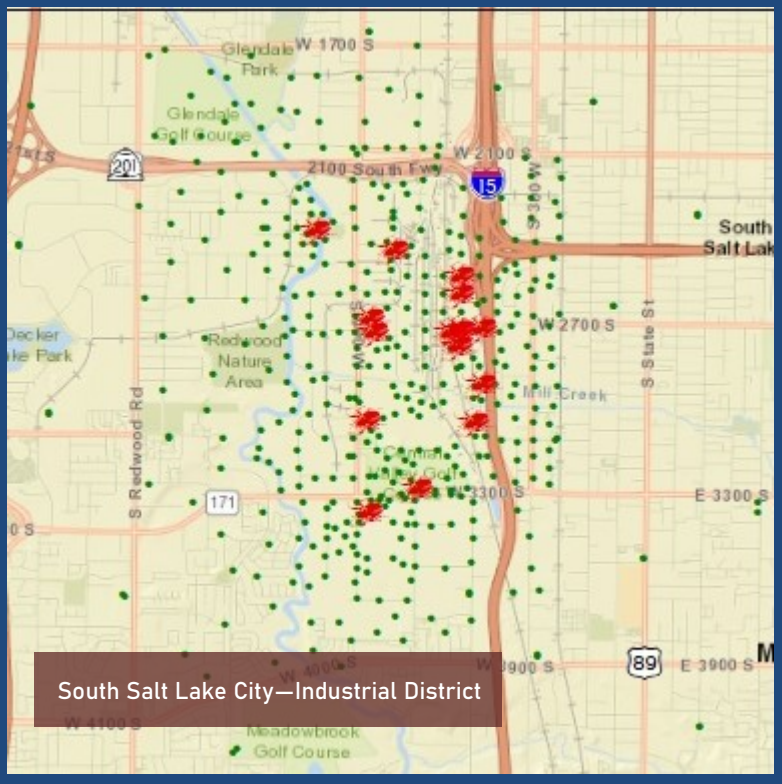


Salt Lake City—Northwest Quadrant

Salt Lake City—International Center

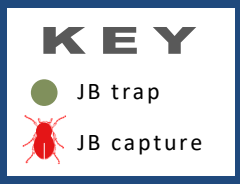


Salt Lake City—Rose Park



South Salt Lake City—Industrial District

MAPS



Kaysville City—Residential area

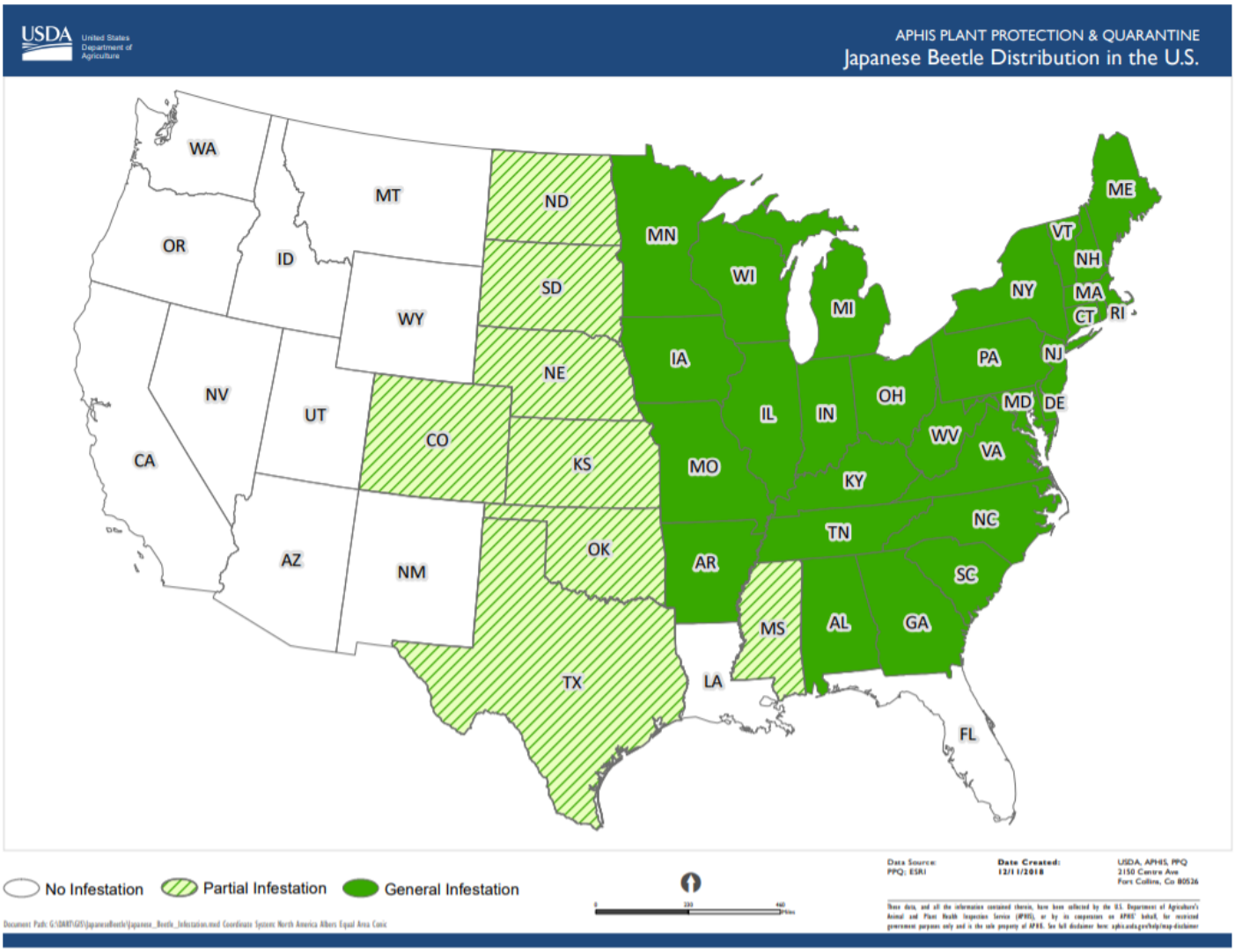
Centerville City—Residential area

In the years after eradication, the number of JB traps placed annually was substantially increased. Indeed, all 29 counties are part of the yearly JB survey in an effort to detect introductions faster. 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 downtown Salt Lake City and in the Avenues neighborhood. Intensive trapping of these locations in subsequent years demonstrated that JB did not establish.

A new population is introduced

In July of 2018, routine trapping of Salt Lake City's west-side industrial district detected a single JB. 150 traps were immediately deployed to determine the extent of infestation. Two more specimens were found near the previous capture site shortly after. In 2019, high-density trapping continued at the same location. Numerous additional beetles were found in the same vicinity. Complicating matters further, traps placed elsewhere discovered five additional locations where JB were 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 for a total of 43 beetles.

Although 43 beetles is far fewer than the thousands detected in the Orem infestation over a decade ago, the UDAF Insect Program has devised a comprehensive eradication plan to ensure that this new population does not gain a foothold in the state. Indeed, acting when the population is small fits well into the UDAF Insect Program's invasive species intervention model of "early detection and rapid response." Thorough pest surveillance that identifies invasive species populations soon after they arrive, coupled with swift action in eliminating the pest has great advantage over a "wait and see" approach. Invasive populations can grow quickly by underfunding survey activities or delaying action when target pests are found. Either tactic increases the cost of eradication later or permits the pest to fester so long that eradication becomes unfeasible. Consequently, in the former case the cost of eradication efforts to taxpayers rises and in the latter case a huge financial burden is placed on producers who must control a pest that previously was not present. As mentioned before, infested states spend nearly half a billion dollars a year in JB related expenses. Keeping Utah JB-free



The distribution of JB in the U.S. In previous decades, California and Utah have successfully eradicated small populations of JB to maintain their non-infested status. Idaho and Oregon are currently eradicating isolated populations in their states to stay JB-free.

will ensure that the state's nursery operators, landscape managers, fruit and vegetable growers and homeowners do not have to shoulder any of these financial burdens.

The eradication plan

In response to these recent detections, the UDAF Insect Program has devised an eradication plan to keep Utah a JB-free state. As part of this plan, UDAF employees will contract and supervise the application of larvicides on turf and other permeable surfaces in areas identified as a JB establishment risk. An application is planned for spring of 2020; additional treatments may be required later in the season, in subsequent years and in other areas not previously identified as high risk. These applications will be applied at no charge to residents and property owners in the affected area.

Based on the at-risk establishment guidelines (see "Box 1"), UDAF will coordinate pesticide applications in Salt Lake City's Northwest Quadrant, including the International Center and areas around the Salt Lake Intermodal Terminal, as well as South Salt Lake City's industrial district. Property owners and managers will be encouraged, but not required, to treat host material in other at-risk areas within Rose Park, Centerville and Kaysville. UDAF will facilitate treatment in these areas with supplies and technical assistance.

Ideally the plan will annihilate the nascent JB population with scalpel-like precision. However insect infestations can sometimes be unpredictable and the plan may need to adapt to accommodate unforeseen challenges. Yet state agricultural authorities believe the project will be highly successful, even if it takes time and dedication to complete. Compared to past eradication efforts of JB and other pests in the state (see "European gypsy moth" on page 15), the present infestation has been detected quite early and the population is minuscule. Yet even the smallest problems can grow enormous if left unchecked; UDAF has no intention of letting this one get any larger.

Box 1: JB risk establishment guidelines

High - Host material within a 200 meter buffer around traps that captured two or more male beetles or one or more female beetles.

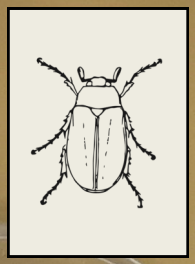
Moderate - Host material immediately outside a 200 meter buffer around traps that meet the "High" standard.

Moderate - Host material within a 200 meter buffer around traps that captured a single male beetle.

UDAF Plant Industry's

ENTOMOLOGY LAB

The Utah Department of Agriculture and Food (UDAF) Entomology Laboratory provides support services to the UDAF Insect Program with expert staff and the latest technology. The lab takes phone calls for general questions regarding insects, and offers walk-in requests for insect identification. Other important functions include:



Honey bee disease diagnostics:

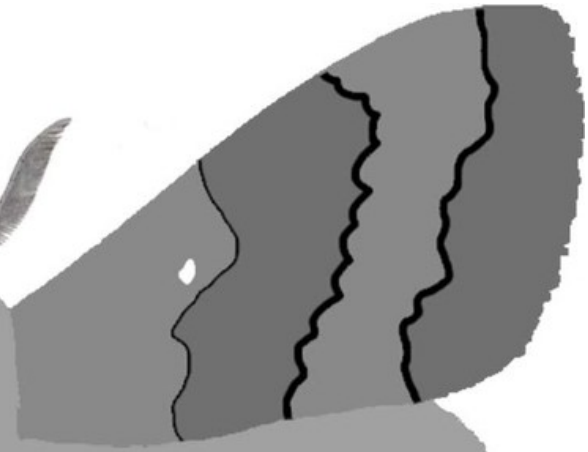
Samples of honey bees are taken at apiary inspections (see page 3) or are submitted by concerned beekeepers. Adult bees are tested for Varroa mite *Varroa destructor* (Anderson and Trueman) using an ethanol wash, tracheal mites *Acarapis woodi* (Rennie) by dissection and Nosema *Nosema spp.* disease by microscopy. Immature bees can be tested for brood diseases. Detection of these pathogens is done through a state-of-the-art process known as quantitative polymerase chain reaction (qPCR). Results from these tests help beekeepers manage healthy hives.

Insect reference collection curation:

The lab's insect collection houses over 5,000 individual specimens representing 150 families of insects collected over approximately 60 years. New specimens are added every year, with emphasis placed on families of agricultural importance. Insects from Utah constitute the majority of the collection with a small portion from other states and foreign countries. Having a quality reference collection of Utah's native and naturalized insects is critical in fulfilling the mission of the UDAF Insect Program. Indeed, when entomologists have a thorough understanding of what is already endemic, exotic pests are easier to detect.

Wood borer survey processing:

The lab processes all exotic wood borer (see page 23) and sentinel (page 8) survey trap catches. This amounts to approximately 150 individual traps that are sampled multiple times in a given season. A technician sorts through every catch and separates the wood borers for identification. Thousands of beetles are identified to species each year, with nearly all being native or already established exotic species.



INVASIVE DEFOLIATING MOTH WATCH

Defoliation can be a normal process for certain plants, such as deciduous trees. In response to cool fall weather, these trees shed their leaves in preparation for winter. However, defoliation that is due to insect feeding can severely damage host plants, even deciduous trees. Leaf loss impairs plant carbohydrate production, which consequently may inhibit growth, cause twig and branch dieback, or even result in death. Defoliating moths damage trees by munching on leaves when they are in their larval (caterpillar) stage, as they are growing and preparing for pupation (cocoon). These insects tend to be polyphagous, meaning they eat a wide range of plants, which is part of the reason why so many of them are important pests.

European gypsy moth

U.S. History

Perhaps the best known defoliating moth is the European gypsy moth (GM) *Lymantria dispar* (Linnaeus). On a quest to find a better silk producing moth, an amateur entomologist imported the European gypsy moth into the United States (U.S.) in the 19th century. The idea was to find a moth that produced as well as the silkworm *Bombyx mori* (Linnaeus), but was resistant to the many diseases which inundated commercial production. Some of the adults accidently escaped their containment and began defoliating trees in the 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 areas in the Midwest and South.

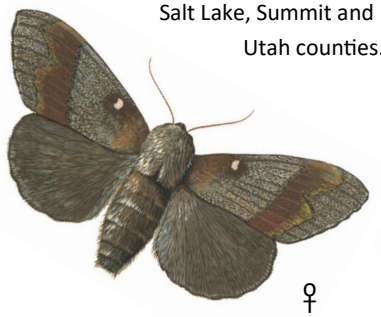
GM is arguably the most devastating pest of forest and shade trees in the Eastern U.S. It prefers hardwood trees, such as aspen *Populus* spp., linden *Tilia* spp., oak *Quercus* spp. and willows *Salix* spp., but like many defoliating moths—it isn't picky. GM can feed on over 300 different trees and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

Utah History

Although Utah is not infested with GM, it wasn't always that way. In 1988 the moth was detected at the University of Utah campus in Salt Lake City. Soon after, additional insect traps were placed in the area where it was found in surrounding counties. Trapping revealed that there were moth populations in urban areas and connecting canyons of Davis, Salt Lake, Summit and Utah counties.

A multi-agency effort between the Utah Department of Agriculture and Food (UDAF), United States Department of Agriculture (USDA) Forest Service, USDA Animal Plant Health Inspection Service (APHIS) and Utah Department of Natural Resources (DNR) began work on eradicating the nascent GM populations. Over the next five years a large-scale eradication plan was implemented. First, the public was made aware of the moth detections and a quarantine of recreational vehicles and household articles was enacted around the areas of infestation. Next, tens of thousands of traps were deployed. Finally, federal and state authorities financed the treatment of 72,000 acres of public and private land over a five-year period (1989-1993). These areas were treated with the bioinsecticide *Bacillus thuringiensis* (Bt). This pesticide was used because of its effectiveness in killing GM and due to its excellent safety record for humans and other animals. In 1994, no moths were caught in any of the thousands of traps placed; the next year yielded the same result.

However, the battle wasn't quite finished. In 1996 seven GM were detected in Salt Lake County locations where the moths hadn't previously been found. High-density trapping the following year resulted in 47 more target insects captured in traps. These findings indicated that there were other



Pine-tree lappet
Dendrolimus pini

growing populations in two separate areas of Salt Lake County's east-bench. More than 1,600 acres would be sprayed over a two year period (1998-1999) to eliminate these populations. By the year 2000 the multi-year, multi-million dollar eradication effort was proclaimed a success. This joint effort had proven that large, separate populations of GM could be eradicated if detected early by pest survey.

Trapping and quarantine efforts

Since the moth was eradicated, the UDAF Insect Program has been vigilantly monitoring for new GM introductions into the state by annually placing approximately 2,000 traps in all of Utah's 29 counties. 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 2019, 2,120 traps were placed statewide and no moths were detected.

Besides trapping efforts, UDAF administers a quarantine (Utah Administrative Code R68-14) to prevent GM from being introduced into the state. 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.

Utah's arid climate, mountainous terrain, lack of natural predators and plethora of host material make the state at high risk for GM infestation and subsequent mass deforestation. However a decision was made many years ago that Utah would stay free of GM. That decision, while costly at the time, continues to pay dividends to the state in economic, environmental and social benefits. The UDAF Insect Program is dedicated to making this legacy endure by preventing future GM introductions.

Asian gypsy moth
Lymantria dispar asiatica

> "A decision was made many years ago that Utah would stay free of gypsy moth. The UDAF Insect Program is dedicated to making this legacy endure."

Defoliating moths from Asia

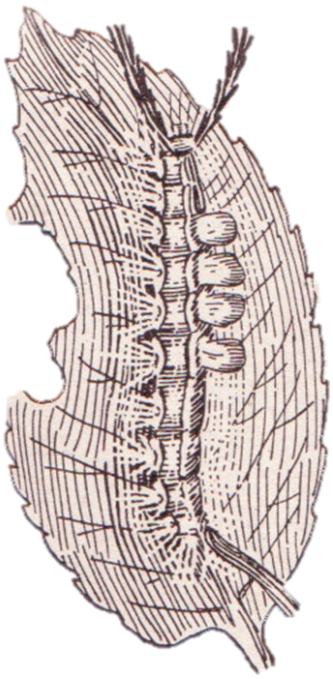
While state and federal efforts continue to impede the spread of GM, there is also work being done to prevent other defoliating moths, which are not known to be established in the U.S., from entering the country. While GM is from Europe, many of these moths are native to Asia. All are potential threats to urban and natural forests.

Asian gypsy moth (AGM) *Lymantria dispar asiatica* (Vnukovskij) is quite similar to GM, however a notable distinction is that AGM females fly, whereas GM females do not. This difference, coupled with a broader host range (nearly double the number of host species that GM attacks), may result in faster dispersal potential compared to GM. Regulatory standards for east Asian countries were adopted in 2012 that requires ships and cargo containers to be found free of AGM before leaving an infested port, or a port of origin itself to be certified free of the pest. However, the number of ships at U.S. ports found with AGM egg masses has only increased in recent years. Consistent monitoring efforts by border, federal and state agencies have resulted in many interceptions. Nonetheless, small populations of AGM have been detected in the Pacific Northwest in recent years. Oregon and Washington states have collaborated with federal agencies to eradicate these populations, with results thus far showing great promise.

Nun moth *Lymantria monacha* (Linnaeus), also known as black arches moth because of its numerous dark wavy lines on the forewing, is considered a major forest pest of conifer and hardwood species in Asia and Europe. Outbreaks of this pest have resulted in large scale forest disturbances in recent decades, causing conifers like pine *Pinus* and spruce *Picea* to die. The time between outbreak intervals has also decreased, happening every several years instead of every few decades.

Rosy gypsy moth *Lymantria mathura* (Moore) is major defoliating pest of forests and fruit trees in eastern Asia, sometimes resulting in complete defoliation of forests. Both the male and female moths are capable of flying, and the dispersal rates of larvae on wind currents are higher than that of AGM and EGM. Though it has not been found in the U.S., it is thought to be a high risk for introduction and establishment around the country including many areas of Utah. Like the other Asian defoliators, rosy gypsy moth has a large host range of deciduous and coniferous woody plants.

Rosy gypsy moth
Lymantria mathura



European gypsy moth
Larvae

European gypsy moth
Adult

Siberian silk moth (SSM) *Dendrolimus sibiricus* (Chetverikov) is a pest native to coniferous forests in north eastern Asia, but has been spreading west into central Europe since the 20th century. It is a significant pest due to its ability to attack and kill healthy trees during outbreak conditions. This moth also has a broad host range of fir *Abies*, spruce, pine, and larch *Larix*, and could likely adapt to North American species if introduced here. In Russia outbreaks have been recorded where millions of hectares of conifer stands were damaged, and tree mortality was as high as 100% in some cases.

Pine tree lappet (PTL) *Dendrolimus pini* (Linnaeus) is native to central Asia and Europe and is primarily a pest of pine species but will host on a wide range of conifers. Outbreaks of pine tree lappet have been recorded for hundreds of years and are associated with tree mortality due to defoliation, with single outbreaks damaging 200,000 to 400,000 acres of forest in Poland and Germany. Scots pine *P. sylvestris*, the pine tree lappet's primary host, is grown in the U.S. as a popular species of pine used for Christmas trees; it is also a commonly planted ornamental tree in Utah landscapes. PTL is also noted as being suited to the biome found in the Intermountain West, which makes it a high risk for establishing breeding populations should it be introduced.

Trapping efforts

Containerized cargo carried on airplanes, ships and trains are thought to be prime opportunities for the artificial spread of these pests due to the bright lighting in shipping ports at night and the tendency of the moths to lay egg masses in small, hidden crevices. Therefore, trapping efforts are focused on high-risk pathways, such as railroad and highway corridors. In 2019, 488 traps were placed in Morgan, Salt Lake and Weber counties, with no target pests detected. Next year's trapping will focus on railyards and international airports within the state.

THE LIFE CYCLE & BIOLOGY OF EUROPEAN GYPSY MOTH

Description: Larvae are dark and hairy and have five pair of blue dots and six pair of red dots on their backs. Adult males are brown with dark zig-zag patterns that span their 1-1/2-inch wings. Females are mostly white and slightly larger, with a two-inch wingspan. Males have feathered antennae, but this is common of members in the Tussock moth family (Erebidae) and thus isn't diagnostic.

Life cycle: Fecund females lay masses of 500-1000 individual eggs on trees, buildings or other outdoor objects. The eggs are the overwintering stage of the insect. Eclosion (egg hatch) occurs in spring and small caterpillars emerge. First instar larvae begin feeding and create small holes in the leaves. The second and third instars feed from the outer edge of the leaf toward the center. Pupation (cocoon formation) begins in early summer and adults emerge in July and August. Adults mate and the life cycle repeats.

Grasshopper & Mormon Cricket SUPPRESSION

Utah has been suppressing populations of endemic pests such as grasshoppers (various genera) and Mormon crickets *Anabrus simplex* (Haldeman) since it was a territory. While these insects are native to the area, many species threaten rangeland and crop production throughout Utah. There are millions of rangeland acres in the state, which provide prime habitat for these pests. If left unmanaged, these insects will destroy rangeland and compete for food with livestock and wildlife. While Mormon cricket populations are at a near 20-year low, grasshopper populations are on the rise. Every year the Utah Department of Agriculture and Food (UDAF), Utah State University (USU) Extension and the United States Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS) cooperate on grasshopper and Mormon cricket surveys to monitor populations. When necessary these organizations will qualify projects for the state cost share program. The cost share program provides landowners reimbursement of up to 25% of the price tag for treating economically threatening grasshopper or Mormon cricket populations on their property. To qualify, land must be infested in excess of eight insects per square yard. When infestations are high, UDAF suppresses grasshopper and Mormon cricket populations on state lands and USDA-APHIS suppresses them on federal land. These efforts are part of the state and federal governments' commitment to providing support for the surrounding land management areas. All stakeholders work together to enable landowners and land managers to be good neighbors and stewards of the land, thereby protecting rangeland and crop yields.

In 2019, USDA-APHIS conducted 3,009 surveys of grasshopper and Mormon crickets throughout the state. Mormon cricket populations were found to be extremely low and there were no reports of these insects causing significant damage from private landowners. However there were some areas of the state where grasshoppers were problematic. Private landowners experienced the highest grasshopper populations with 232,229 infested acres, federal property was second with 58,961 infested acres, state lands had 35,651 infested acres and tribal lands were the least infested with just 31,582 acres. In total, approximately 358,423 acres were infested, which was about 250,000 acres fewer than in the previous year. However, UDAF and USDA-APHIS expects that populations will rise in 2020, unless spring weather is unseasonally cold and winter-like. Pest populations were largely detected in historical areas of concern. These places include: Beaver, Box Elder, Sanpete, Sevier, Millard, Tooele, Duchesne and Uintah counties. Some farmers and ranchers experienced grasshopper populations as high as 50-70 per square yard. This caused severe damage to cropland areas when populations persisted.

UDAF approved 23 cost share agreements to assist in 2019 control efforts. Roughly 1,400 private acres were treated through these agreements. Landowners in three counties participated in the program, the majority of which were in Beaver County. All program funds were provided to cost share agreements with private landowners and no aerial or ground treatments were carried out by state or federal governments in 2019.

Box 1: Predominant grasshopper species detected in 2019.

Pasture grasshopper *Melanoplus confusus* (Scudder)
Clearwinged grasshopper *Camnula pellucida* (Scudder)
Big-headed grasshopper *Aulocara elliotti* (Thomas)
Packard's grasshopper *Melanoplus packardii* (Scudder)
Migratory grasshopper *Melanoplus sanguinipes* (Fabricius)

VELVE
LONGHORN
BEET

When an invasive beetle was detected in Utah a decade ago, a multi-agency partnership formed in response. After years of trapping and

ET
NED
TLE

In 2010 the invasive wood borer velvet longhorned beetle (VLB) *Trichoferus campestris* (Faldermann) was detected for the first time in Utah. Four specimens were found in an insect trap placed within "Tile Mile," a section of South Salt Lake City nicknamed for the area's floor covering merchants. Although only a few beetles were found, the situation was concerning. VLB is indigenous to Asia and was not known to be established anywhere in the country. In the United States (U.S.), it had been previously intercepted at ports of entry and in warehouse settings across the Midwest and East. However, it had yet to be found in an urban area. This mattered because, in its native range, VLB reportedly attacked ornamental trees commonly planted in urban canopies such as birch *Betula*, honey locust *Gleditsia* and willow *Salix*.

In subsequent years, hundreds of VLB were found near the original site and it became apparent that Salt Lake County had a severe VLB infestation. The pest would soon be found in a commercial fruit orchard in Utah County. This was distressing because VLB was also known to attack live apple *Malus*. trees in its native range.

research, efforts begin to come to an end.

The state was not in a good position to deal with this situation for a couple of reasons. Firstly, although insect traps were catching VLB, these traps were designed to attract different insects such as other wood boring beetle species, gypsy moth and Japanese beetle. It was not clear at the time if the traps were especially effective at catching VLB or if there were so many of these insects present that they just coincidentally ended up in traps. Secondly, treatment methodology for this insect had not been well researched. Eradicating insects is much easier if there is a reliable and cost-effective way to determine the extent of infestation, it is clear how to eliminate the pest and the population is detected quickly after introduction. Utah possessed none of these advantages.

Just a few years after first detection the prospect of eliminating VLB from Utah dimmed, yet 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 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 proven trap and lure methodology and determining what other valuable host trees VLB might attack, aside from those already known. The Utah Department of Agriculture and Food (UDAF) Insect Program agreed to assist CPHST with these endeavors and by mid-decade a number of scientific projects began.

Trap and lure studies

A series of trap and lure studies were headed by Dr. Annie Ray of Xavier University and Dr. Joseph Francese of CPHST. As previously mentioned, VLB had been detected in various insect traps, however none were designed to attract VLB. Indeed the pest was so new to the U.S. that a proven trap and lure combination didn't exist. This was one factor that made it extremely difficult for the UDAF Insect Program to determine areas of infestation and track pest movement. Without effective trap and lure technologies, pest-detection programs are limited to the time consuming and expensive option of visual survey. Thus these scientists set up experiments that evaluated the capture success based on different trap types, colors, height deployment and lighting. It was determined that cross vane panel traps treated with a fluoropolymer resin performed best (see picture on page 22). Black traps were more effective compared to other colors or clear. Finally, placing the traps at ground level appeared to have better results than raising the traps high into trees. As reported in Ray et al. (2019), these researchers also identified a male

"Without effective trap and lure technologies, pest-detection programs are limited to the time consuming and expensive option of visual survey."

-produced aggregation pheromone and created a synthetic analog (later named Trichoferone), which could be used as an attraction lure for the cross vane panel traps. The UDAF Insect Program contributed to these projects in 2019 by checking, servicing and maintaining 64 Trichoferone-baited traps placed in an infested orchard, from early July to mid-August. The experimental design's aim was to determine the effectiveness of different Trichoferone concentrations and the addition of the light to traps in attracting VLB. Although these studies are not entirely concluded, an effective trapping method has already been developed and is currently in use around the country and in Utah for survey purposes.

Host range evaluation

Another group of researchers, led by Dr. Baode Wang and Dave Cowan of CPHST, began two scientific projects to determine what host materials VLB might attack in the U.S. One study involved the attachment of sleeve cages to the limbs and trunks of potential host trees at parks, golf courses and fruit orchards that were heavily infested with VLB. Sleeve cages are made of flexible wire mesh, which can be wrapped around the tree and secured with zip ties. These type of cages were picked for this study because VLB is a wood boring pest, meaning its larval stage feeds on the inside of trees and after pupation an adult emerges from the bark. If a sleeve cage happens to cover a section of the tree where a wood borer emerges, it will become trapped. A VLB trapped in a sleeve cage attached to a species of tree that is not previously known to be a host provides useful information and is declared a "new host record." In 2019, the UDAF Insect Program weekly checked, serviced and maintained about 90 sleeve traps placed at four separate locations from late May to late August.

The second study involved the planting of 30 ornamental and fruit trees for the purposes of creating a research orchard. Trees such as maple *Acer*, ash *Fraxinus*, walnut *Juglans*, apple, poplar *Populus*, peach and cherry *Prunus*, pear *Pyrus*, black locust *Robinia*, Japanese pagodatree *Styphnolobium* and honey locust were selected for this project. Once the trees were planted zippered sleeve cages were attached to the trunks, so that staff could purposely introduce a male and female VLB into a contained section of the tree surface. The idea is that the male and female will mate, the female will lay eggs on the bark surface and if the plant is acceptable host material, larvae will burrow into the tree after egg hatch. If new adults emerge from the tree in the following year, scientists will know that this plant species is a potential host for VLB. If no adults emerge, then it is not likely adequate host material. From June through August, 67 live male and female pairs were captured and placed in zippered sleeve cages attached to trees at the research orchard. UDAF Insect Program staff will be checking these trees for emerging VLB adults next year.

Neither study is complete, so a full host list has yet to be published. However these efforts have already confirmed that VLB can attack live cherry and peach trees. This was a stunning and disconcerting development. As mentioned, it was previously known that this pest

Insect trappers service a black cross-vein panel trap, which captures VLB. The trap and lure combination was developed in the state by USDA scientists with the help of UDAF. Other states are now using this trap to monitor for VLB.

fed on apple trees; however it was not clear whether it would attack other economically important fruit trees.

State-led survey efforts

While these scientific projects were happening, the UDAF Insect Program began surveying different areas of the state with the new trap and lure methodology to determine where VLB had spread. Since 2016, 25 traps have been placed annually in eight different Wasatch Front counties to track movement of the pest. Previous years trapping revealed the beetle to be in Davis, Salt Lake, Tooele and Utah counties. In 2019, new host records were detected in Box Elder, Summit and Weber counties. At this point, VLB is everywhere the state has surveyed.

Living with VLB

After a decade of effort on VLB-related projects, the UDAF Insect Program's work is coming to an end. In 2020, the state-led VLB distribution survey will be suspended and Utah will be considered "generally infested." Collaboration on the trap and lure studies will also be drastically reduced. Yet, the state will continue monitoring for VLB spread through the exotic wood borer survey (see page 23) and assist CPHST with the host range evaluation studies, as these efforts are still in progress.

Although many of the Utah's contributions are wrapping up, the achievements made over the past decade have been meaningful. An effective trap and lure has been developed, which will help other states to monitor and possibly exclude VLB. New host materials have been identified. Education and outreach has helped prepare producers and landscape managers to deal with the newly established pest.

Finally, the VLB experience serves as a powerful reminder of the ease with which invasive pests can spread. A possible pathway of VLB introduction was via wooden pallets, which carried products from Asia to Utah. The detection of this insect in the middle of a landlocked Western state demonstrates the global nature of today's commerce and supports the notion that natural barriers such as oceans cannot be relied upon to prevent exotic insect transmission. This illustrates the importance of having robust invasive detection even in places as seemingly unlikely to be a site of invasive pest introduction as "Tile Mile."

MEET THE BEETLES!

Exotic wood boring beetles pose a serious threat to Utah's urban and natural forests. Invasive insect detection is the first step in preventing their establishment.

Natural and urban forests across the country face multiple threats that can profoundly influence the dynamics of their ecosystems. Anthropogenic disturbances account for many negative impacts on forest health, and the introduction of invasive insects is one of the most devastating of these. Exotic wood boring beetles are a group of invasive pests that feed on woody plants in their larval and/or adult stages, and are of particular concern for a number of reasons:

- Larvae can be transported unnoticed in untreated wooden packing material and nursery stock.
- Without natural enemies from their endemic range, populations can be poorly regulated and grow at much faster rates than in their native landscape. When populations are high, healthy trees are more prone to being attacked by pests that may otherwise only attack unhealthy trees.
- Invasive insects can introduce exotic plant pathogens or may serve as effective vectors of established pathogens (e.g. the banded elm bark beetle *Scolytus shevyrewi* (Semenov) transmitting Dutch elm disease *Ophiostoma ulmi*).
- There may be overlap in ecological niches of native and exotic organisms, resulting in native species being displaced (e.g. emerald ash borer *Agrilus planipennis* (Fairmaire) and specialist herbivore insects that feed on ash *Fraxinus*).

The state administers a quarantine (Utah Administrative Code R68-23) which is meant to prevent importation of exotic wood boring pests into the state (see Box 2 on page 25). Quarantines can be thought of as a "first line" of defense. Another line of defense is trapping, which is also an essential tool in mitigating the decline of forest and urban tree health. When exotic insects are detected early with trapping, 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 wood boring beetle species, all of which fall into one of three large families of beetles. 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, with a great variation of colors and habits. The larval stages of these families infest the inner wood of trees and adults will feed on host material as well.

Cooperative Agricultural Pest Survey exotic wood borer targets

The United States Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS) coordinates the Cooperative Agricultural Pest Survey (CAPS) program, a science-based federal and state effort to detect exotic organisms that are a threat to 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 2019, 88 traps were placed in riparian corridors, wood processing facilities and municipal parks to target seven different pests. With the exception of the velvet longhorned beetle *Trichoferus campestris* (Faldermann), none of these survey targets has ever been found in Utah. In 2020 UDAF Insect Program will continue participation in the CAPS exotic wood borer survey.

Black fir sawyer and 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

BOX 1:
CAPS SURVEY PEST LIST

Black fir sawyer
(*Monochamus urussovii*)

European spruce bark beetle
(*Ips typographus*)

Japanese pine sawyer
(*Monochamus alternatus*)

Large pine weevil
(*Hylobius abietis*)

Mediterranean pine engraver
(*Orthotomicus erosus*)

Sixtoothed bark beetle
(*Ips sexdentatus*)

Velvet longhorned beetle
(*Trichoferus campestris*)

coniferous trees. Black fir sawyer *Monochamus urussovii* (Fischer-Waldheim) is native to spruce *Picea* and fir *Abies* 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 United States (U.S.), though *M. alternatus* was intercepted once in a New York warehouse in the 1990s.

Large pine weevil

Large pine weevil *Hylobius abietis* (Linnaeus) is a commercially important pest of pine plantations in Europe and Asia and causes millions of dollars in damage annually. The larval stage of the beetle does not cause significant damage to living trees as eggs are laid in recently cut tree stumps, but the adults feed on a large variety of many 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 through the mail.

Mediterranean pine engraver

Mediterranean pine engraver *Orthotomicus erosus* (Wollaston) is a bark beetle native to southern Europe, Asia, and northern Africa. Populations of the invasive pest were found in California in 2004. Since 2008 it is currently present in 10 counties within the Central Valley of the state. There have been no other reported established populations in the U.S., but it has been intercepted at several ports of entry. This beetle has a large primary host range of pine *Pinus* species, but can attack other coniferous trees such as spruce, cedar *Cedrus*, and fir. Pine populations in areas where the beetle is established have seen significant damage from this pest. It will normally feed and oviposit on dead trees but will attack stressed living trees, such as North American pine forests under pressures like drought and fire.

European spruce bark beetle & six-toothed Ips

Ips bark beetles are moderate to large bark beetles (up to 8 mm in length) that feed on coniferous trees. European spruce bark beetle *Ips typographus* (Linnaeus) specializes in spruce trees and is native where Norway spruce *P. abies* is naturally found in Europe. 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, 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

See page 19.

State wood borer targets

Pine shoot beetle

Pine shoot beetle *Tomicus piniperda* (Linnaeus) is an invasive bark beetle with a large native range in Eurasia and North Africa that was first detected in Cleveland, Ohio in 1992. Since its introduction, pine shoot beetle has spread throughout much of the Northeast and Midwest. Most damage is caused by adults feeding inside young shoots of heathy 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. Pine shoot beetle has never been detected in Utah.

Emerald ash borer

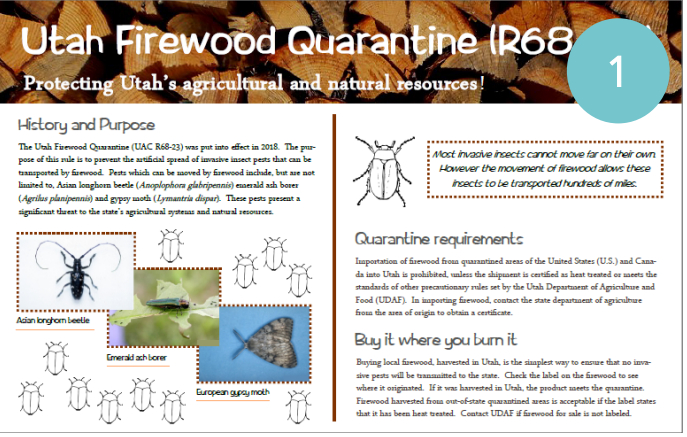
Popularly known as "The Green Menace" emerald ash borer (EAB) has lived up to its nickname by decimating all species of ash trees *Fraxinus* in the U.S. since its first detection in Michigan in 2002. Although small (1/2 inch in size), it should not be underestimated. In the last two decades EAB has spread 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 in 2013 when it was found in the neighboring state of Colorado. It is currently found in four counties of that state.

In recent years, the UDAF Insect Program has been preparing for EAB introduction by forming a task force of partner agencies and groups, including USDA-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 educating the public about the dangers of moving firewood, outreach to local tree care professionals on EAB identification and active surveying for this pest. 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 which are suspected to be infested. The UDAF

BOX TWO

THE UTAH FIREWOOD QUARANTINE

To prevent the entry of new exotic wood borers, the state conducts enforcement work of the recently enacted firewood quarantine (see Utah Administrative Code R68-23), which 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 the new rules. State compliance specialists have also been visiting retail locations that sell firewood, to make merchants aware of the new rules.



Box 3: UDAF takes a multipronged approach to excluding wood boring pests. 1) Regulatory: the state's firewood quarantine prevents pest introduction, as outlined by this fact sheet 2) Survey: pests can be detected early with insect traps, such as this Lindgren funnel trap used to detect EAB. 3) Outreach: UDAF staff educate producers and the public about how they can prevent pest introduction.

Insect Program and others have also responded to dozens of EAB infestation claims by homeowners and landscape managers. Nonetheless, there have been no confirmed cases of EAB in Utah to date.

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 considering removing their domestic EAB quarantine. Consequently federal funds directed toward trapping would be reallocated to biocontrol and research. As a result of this announcement, the UDAF Insect Program made the decision to increase the number of state traps and employ an improved trapping methodology. The latter was accomplished by utilizing trapping techniques described by Ryall et al. (2013), which claim to provide improved detection of EAB when infestation rates are low. The method involves close placement of two green Lindgren funnel traps (see photo "2" above) per site and a combination of chemical lures (hexanol and lactone) attached to each trap. This trapping method is thought to be advantageous to the previously used method—a purple prism trap baited with Manuka oil.

In 2019 the UDAF Insect Program and task force partners coordinated the placement of 51 EAB traps in Beaver, Cache, Emery, Grand, Iron, Salt Lake, Utah and Weber 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 2020 the UDAF Insect Program will continue coordinating task force efforts such as trapping, visual survey and education efforts about EAB and the firewood quarantine.

European Corn Borer

History

European corn borer (ECB) *Ostrinia nubilalis* (Hübner) was first identified 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.

Improvements in control

However, the situation was dramatically improved with the extensive adoption of transgenic 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, the development of resistance to Bt corn is a cause for concern. 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 peppers *Capsicum annuum*, certain ornamental plants, and non-Bt corn.

Protecting Utah's growers

Utah has successfully maintained a quarantine of this pest for many decades. The effort to keep Utah free of ECB includes pest-free certification of certain agricultural commodities imported into the state, as well as a statewide trapping survey. In 2019, 85 traps were placed across Box Elder, Cache, Davis, Duchesne, Millard, Morgan, Sevier and Uintah counties. No ECB were detected from these efforts.

UDAF Insect Program staff and seasonal crew

TOP ROW (left to right): Kristopher Watson (program manager/state entomologist), Jeffrey Larson (Japanese beetle/gypsy moth trapper), Alan Lindsay (Japanese beetle/gypsy moth trapper), Sarah Poncher (Japanese beetle/gypsy moth trapper), Sharon Gilbert (lead trapper), Joey Caputo (survey entomologist/honey bee inspector) and Sally Crawley (Japanese beetle/gypsy moth trapper).

BOTTOM ROW (left to right): Anne Johnson (GIS specialist), Mary Beninati (wood boring beetle trapper), Vale Nielson (Asian defoliator trapper), Sarah Schulthies (lab technician) and Stephen Stanko (honey bee inspector),

NOT PICTURED: Jerry Shue (Japanese beetle/gypsy moth trapper/Africanized honey bee surveyor).

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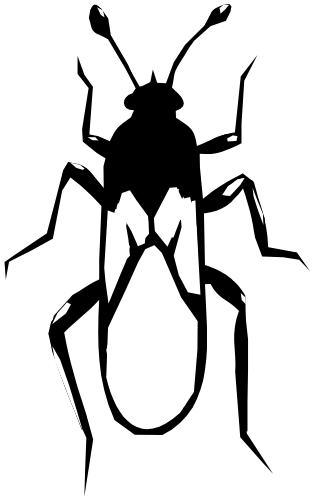

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WEB RESOURCES

APIARY

UDAF Apiary Program

https://ag.utah.gov/farmers/plants-industry/apiary-inspection-and-beekeeping/

USDA-ARS Pollinating Insect-Biology, Management, Systematics Research

https://www.ars.usda.gov/pacific-west-area/logan-ut/pollinating-insect-biology-management-systematics-research/

Project Apis m.

https://www.projectapism.org/

Apiary Inspectors of America

https://apiaryinspectors.org/

INVASIVE INSECT DETECTION

UDAF Invasive Insect Program

https://ag.utah.gov/farmers/plants-industry/

USDA-APHIS-PPQ

https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases

Utah Cooperative Agricultural Pest Survey Program

https://utahpests.usu.edu/caps/utah-caps-program

Utah Plant Pests Diagnostic Laboratory

http://utahpests.usu.edu/uppdl/

National Plant Board

https://nationalplantboard.org/

UTAH TRADE ASSOCIATIONS

Utah Nursery and Landscape Association

http://www.utahgreen.org/

Utah Horticulture Association

https://extension.usu.edu/productionhort/fruit/tree/untitled

Utah Beekeepers Association

http://www.utahbeekeepers.com/

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