

2017 Forest Health Highlights



Michigan Department of Natural Resources

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Introduction

During 2017, the Michigan Department of Natural Resources mobilized to contain the Hemlock Woolly Adelgid, celebrated the planting of beech bark disease-resistant trees in Ludington State Park where the fungal disease was first discovered in 2002 and continued efforts to keep the maple-killing Asian Longhorned Beetle out of the state.

This report brings the public up to date on these and other forest health efforts affecting nearly 20 million acres of forest land in Michigan. The DNR has partnered with the National Forest Health Monitoring Program to track changes and note challenges and successes since 1995. Learn more about the DNR's Forest Health program at www.michigan.gov/foresthhealth.

The Michigan Department of Natural Resources is committed to the conservation, protection, management, use and enjoyment of the state's natural and cultural resources for current and future generations.

For more information, visit www.michigan.gov/dnr.

Acknowledgments

Forest Health Highlights is a summary of the condition of Michigan's forests during 2017 and the work done to preserve and protect them by the Michigan Department of Natural Resources Forest Resources Division and its partners.

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Cover photo: Forest tent caterpillar.

Photo by Michigan Department of Natural Resources forest health specialist Scott Lint.

Roger Gerard Mech - what you don't know

Roger Mech has retired from the DNR's Forest Health Program.

Many people, though not all, will miss his rapier and incisive wit. Roger, or Rog, was the last vestige of the Michigan Cooperative Forest Pest Management Program. He stood on the shoulders of Forest Pest Management giants Paul Flink, Dan Mosher, Gary Simmons, Lou Wilson, John Witter, Ron Murray and, of course, the recently retired Bob Heyd.

During the mid-1980s, Roger was the principal author of a white paper that set forth a public policy to guide management of gypsy moths in Michigan. The central philosophy behind that document is still active today, and it kept Michigan off of the slippery slope leading to massive spraying of public land.

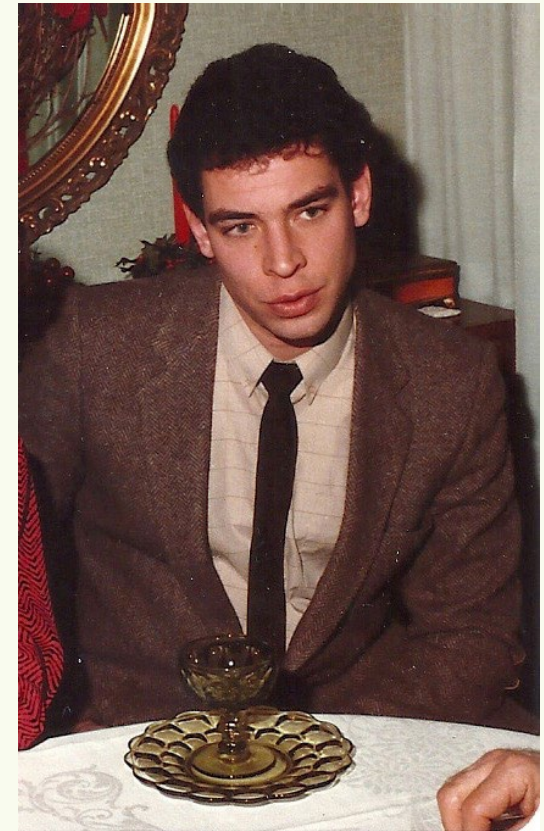
Roger was instrumental in the adoption and testing of various forest health management technologies nationally. Roger was known as a practical joker, and sometimes as the target of practical jokes. Before the internet really took off, Rog was the subject of a "personal" home page that featured him standing in shorts, an Australian digger hat and desert gear at the Sonoran Desert Museum in Arizona. It had interviews with former girlfriends, his tastes in music, favorite harmonica players and even his personal guacamole recipe. Roger, of course, knew nothing of this web page till one afternoon he noticed it being displayed on every PC at the Roscommon Regional Headquarters!

An accomplished blues harmonica player, Roger is comfortable making a French boule or throwing a Frank Pepe's Apizza Napolitano white clam pie into the oven. His homemade cassoulet, his penchant for the latest offering from the GlenWyvis distillery in Scotland or his enjoyment of a Flor de Las Antillas Maduro Corona cigar clearly place Rog in the category of epicure.

There is lots more I could write here regarding Rog and his lovely wife Beth. His commitment to family, special needs kids or his esoteric and narrow taste in music and beer. What is certain and more important is that dedicated professionals like Rog have made sure that Michigan's 20 million acres of forest land and the rich diversity of our urban and rural forests are less threatened by exotic insects, plants and diseases.

Thanks Rog.

-Frank J. Sapio



Hemlock Woolly Adelgid

The Michigan Department of Agriculture and Rural Development contributed this story.

Hemlock woolly adelgid is among the most serious threats to forest ecosystems in Michigan and the nation. More than an estimated 176 million hemlock trees grow in Michigan. Failure to manage this pest within Michigan could result in the loss of hemlock from state forests in Michigan and neighboring states, dramatically altering them.

The adelgid – referred to as HWA -- is believed to have been introduced into Michigan on infested landscape trees brought into the state before, or in violation of, a statewide quarantine.

Response to multiple HWA infestations detected in Michigan from mid-2015 through 2017 continues. The infested sites are scattered along the eastern Lake Michigan shore area from Oceana County to the north and Allegan County to the south. Five Michigan State Parks are among the sites infested. The size and scope of the sites range from a single property with a dozen or so infested trees to multiple properties with hundreds of infested trees. Property owners and land managers are using pesticide treatments.



Hemlock woolly adelgid-infested hemlock branch.

The Michigan Department of Agriculture and Rural Development (MDARD) established an interior state quarantine effective July 5, 2017, to keep the insects from spreading out of west Michigan. The exterior quarantine, established in 2001, remains in place. The interior quarantine regulates movement of hemlock material out of and within Allegan, Muskegon, Oceana and Ottawa counties. It regulates hemlock nursery stock, not-composted chipped/shredded/ground or mechanically processed forest products containing hemlock; and hemlock forest products bearing twigs and needles, including branches, boughs, logs, lumber and firewood.

An HWA Nursery Program allows movement of nursery stock based on inspections, scouting, pesticide

Projecting Hemlock Woolly Adelgid Distribution and Risk in Michigan

*Deborah G. McCullough, Jeffrey A. Andresen, Phoebe Zarnetske, Nina Lany and James Wieferich
Michigan State University*

Will Michigan's cold winters work against the hemlock woolly adelgid? Michigan State University researchers are working to find an answer to that question.

Most insects spend the winter in a dormant state, but the adelgid – known as HWA -- actively feeds and matures throughout the winter and spring. Laboratory studies and observations in New England have shown cold winter temperatures sometimes kill many of them. However, mortality rates and the temperatures associated with that mortality vary considerably among studies.

Objectives of our current research include:

- Developing a statewide map of hemlock distribution and abundance using an array of data sets and variables.
- Monitoring HWA survival and tracking development of life stages on infested trees in western lower Michigan
- Monitoring winter temperatures on individual hemlock trees in four lower Michigan locations and two

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- Upper Peninsula sites to quantify differences among regions of the state, as well as the extent of microclimatic differences for individual hemlocks at each location.
- Evaluating extreme and average winter temperatures recorded in Michigan and across the Great Lakes States region from 1980-2016.

Results to date show the strong influence of Lake Michigan and the other Great Lakes on the frequency and severity of extreme cold events. Coldest temperatures and the most frequent extremes occur to the west and north of the lakes as well as in interior areas away from the lakes. The mildest readings were recorded in lakeshore areas of southwest lower Michigan, a pattern consistent with the thriving HWA populations in this region.

Ultimately, we plan to combine data from our temperature and climatic evaluations with the statewide hemlock map to identify areas where hemlock is abundant and HWA is most likely to thrive, as well as areas where severe winters may slow HWA population growth and the impact of the insects.

Hemlock Woolly Adelgid

The Michigan Department of Agriculture and Rural Development contributed this story.

treatments, employee training and record keeping. A similar program is in several states and Canada to assure hemlock nursery stock is HWA-free.

In early 2017, a committee was established to create a coordinated statewide strategy to respond to HWA. Priorities include: prevention, detection, treatment, biological control, research, data collection/management, coordination/communication and identifying long-term ways to pay for it. Both long and short-term objectives are being considered. The committee includes representatives from the Michigan departments of Agriculture and Rural Development and Natural Resources, USDA-Forest Service Michigan State University and Ottawa County Parks and Recreation.

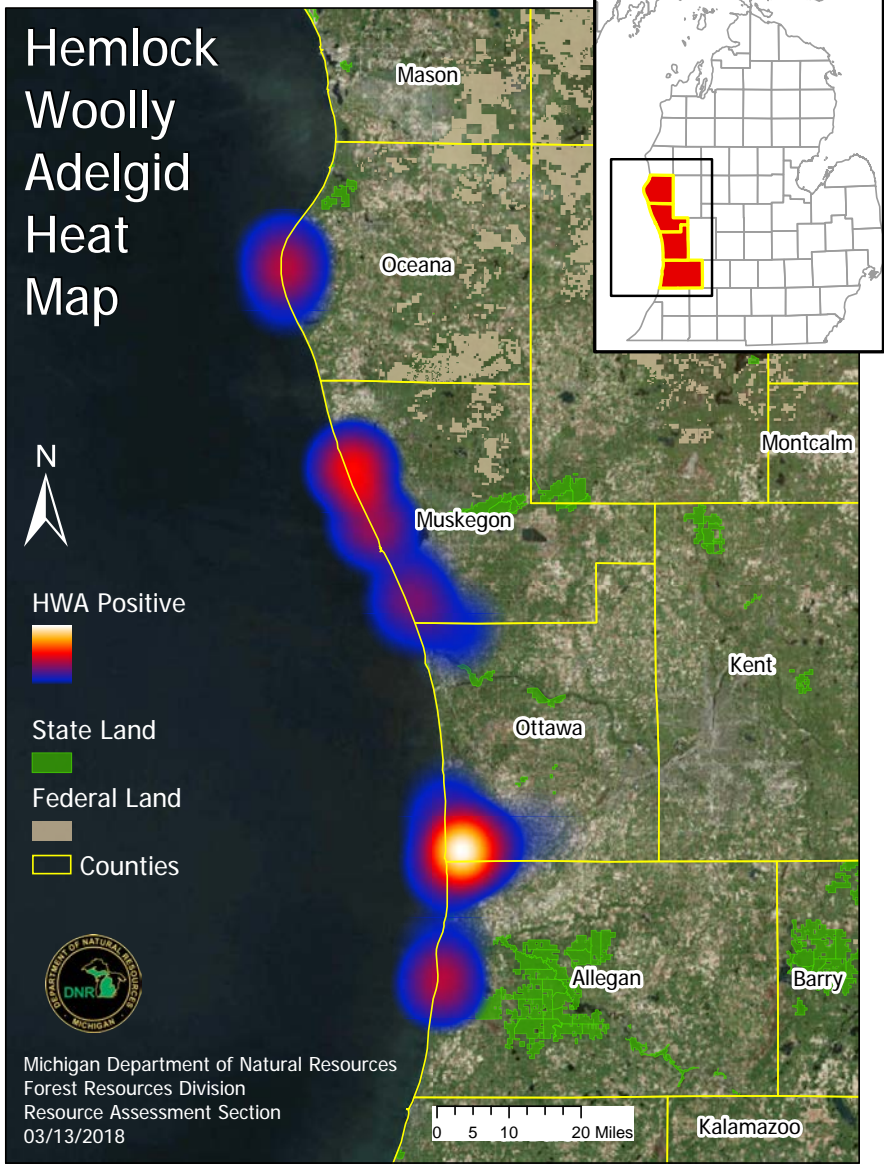
Statewide outreach and education on HWA continues. For more information about HWA, visit www.michigan.gov/HWA.

Hemlock woolly adelgid control in state parks

Michigan Department of Natural Resources staff contributed this story.

The first detection of hemlock woolly adelgid on state managed property was found at P.J. Hoffmaster State Park in early January 2017, prompting a broad survey response from the Department. That survey effort led to new detections at Holland, Muskegon, Duck Lake and Silver Lake State Parks. Currently, the infestation at Silver Lake State Park is the northernmost extent of known HWA infestation.

The DNR began treatment of infected and nearby trees in the summer of 2017 with the help of AmeriCorps members from Parks and Recreation Division's Michigan Civilian Conservation Corps. Infestations were treated with systemic insecticides at all five infected parks including sites near the popular Genevieve Gillette Visitor Center at P.J. Hoffmaster State Park and Snug Harbor in Muskegon. Treatments covered 245 acres of hemlock with an additional 81 acres surveyed. The DNR Parks and Recreation Division hopes to continue this effort to protect and save the hemlock resource in the sensitive dune landscape. Parks and Recreation Division plans to map and survey the at-risk hemlock with special attention to protect scenic areas, campgrounds and ecologically sensitive locations.



Evaluation of systemic insecticides to control beech scale

James B. Wieferich and Deborah G. McCullough, Departments of Entomology and Forestry, Michigan State University

Researchers are looking at ways to use common pesticides to help save beech trees in Michigan.

Minute wounds in the outer bark are created by thousands of beech scales feeding on large branches and the trunk of beech trees. These wounds allow fungal spores to infect and kill patches of cambium and phloem. As patches of dead tissue coalesce, large branches and eventually the entire tree are killed.

Since 2014, we have been evaluating selected insecticides that could be used to control beech scale and prevent or delay infection by the fungus. While these products are not likely to be used in forested settings, they certainly could protect beech trees in landscapes.

In our first study, we quantified live and dead beech scale insects on bark samples taken from infested beech trees that were treated with a trunk injection of TreeAzin® and from trees left as untreated controls. TreeAzin is a systemic insecticide with azadirachtin as the active ingredient.

We were interested in this product because azadirachtin, which is derived from the Neem tree, native to India, is not toxic to birds or mammals.

Continued...

Beech Bark Disease

There's a glimmer of hope for beech trees, thanks to disease-resistant saplings being raised in a U.S. Forest Service lab in Ohio. More than 200 of them were planted in Ludington State Park in fall 2017.

Since beech bark disease was first discovered in Michigan in 2000, impacts from it have become increasingly widespread and severe.

Beech trees are abundant in many campgrounds, state parks and recreation areas in Michigan, and beech bark disease has caused removal of dead or dying beech

trees at popular tourist attractions such as Ludington State Park, Bass Lake Campground and Tahquamenon State Park. The loss of overstory beech dramatically affected the aesthetics of treasured natural areas as well as the productivity, biodiversity and health of the forests. Beech bark disease is caused by the feeding activity of the non-native invasive beech scale insect that creates bark openings, providing entry points for fungal infection to occur. Fortunately, a small percentage of beech trees have natural resistance to the scale.

The Michigan Department of Natural Resources has been working with the U.S. Forest Service Northern Research Station to select and breed for resistant American beech trees since 2002. Protocols were developed to test trees and seedlings for resistance to the scale insect. Genetic studies demonstrated that when two resistant parent trees are bred, about half of the resulting seedlings will also be resistant. This work culminated in the establishment of seed orchards



Volunteers Jim Sillery and Mary Ann Reiner plant disease-resistant beech trees at Ludington State Park.

consisting of resistant American beech trees that will one day produce seedlings enriched for resistance to beech bark disease, appropriate for restoration plantings in the Upper Peninsula. Current efforts are focused on the development of a similar seed orchard for restoration of beech in the Lower Peninsula.

It may take 10 or more years for the seed orchards to begin to produce seed. To accelerate production of resistant seedlings, recent work has focused on the development of containerized seed orchards. This involves grafting a branch from a mature, flowering, resistant beech tree to a potted seedling. The two grow together, allowing the resistant branch to flower. Cross-pollinations and seed production can be carried out in the more reliable, controlled environment of a greenhouse. Germination rates of beechnuts produced in this way are substantially higher, so a small, potted beech tree can produce dozens of seedlings.

After 15 years of research this work has now come full circle. Seedlings produced by potted resistant trees, some of which originated from Ludington State Park, were planted throughout the park this past fall with the help of DNR officials, U.S. Forest Service researchers and volunteers.

The seedlings were returned to areas throughout the park including the aptly named Beechwood Campground, to replace many of the large, mature beech trees lost to this devastating disease.



Three generations of campers plant disease-resistant beech trees at Ludington State Park.

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Trees were first treated in 2014 then re-treated in 2015.

Results showed that the trunk injections of TreeAzin caused some beech scale mortality, but levels of control were not nearly high enough to adequately protect trees.

We then set up studies to evaluate basal trunk sprays of a Safari®, a systemic insecticide with dinotefuran as the active ingredient. This insecticide is widely used to protect landscape trees from insects such as emerald ash borer and some native scale insects. We also evaluated basal trunk sprays of a surfactant sold as Pentra Bark®. This is a relatively inexpensive and non-toxic product that is similar to a detergent. These trials showed that if scales were directly sprayed with Safari, they were killed. However, we found no evidence the insecticide killed scales above the spray line. Systemic insecticides like Safari are transported in the xylem cells (sapwood) that carry water from the roots to the canopy. The beech scale insects, which feed on phloem just beneath the outer bark, may be too small to actually encounter the insecticide moving in the xylem cells. Somewhat unexpectedly, we found the Pentra Bark killed all the scales that were directly sprayed. Although it needs to be tested operationally, this non-toxic product could be a good option for controlling beech scale with little harm to applicators or non-target insects.

Oak Wilt Management in Michigan State Parks

Ongoing oak wilt management at five state parks and recreation areas has resulted in losses of fewer trees. Infected areas included Island Lake and Proud Lake state recreation areas and South Higgins Lake, P.J. Hoffmaster and Warren Dunes State Parks. Approximately 3,100 feet of root graft barrier was installed using a vibratory plow. Some sites in dune habitat will be girdled rather than plowed.

In most instances, oak wilt infection is linked with firewood movement in state parks, detections at Proud Lake Recreation Area resulted from negligent pruning from a local tree care company and park neighbor in May 2017. Shortly after wounding, five trees near protected Eastern massasauga rattlesnake habitat wilted. This highlights the importance of adhering to pruning guidelines, especially in areas with high oak wilt potential.

Oak wilt management continued at Belle Isle State Park. In partnership with the Belle Isle Conservancy and with funding from the Michigan Invasive Species Grants Program, DNR Parks and Recreation Division protected 181 vulnerable red oaks from the disease. Following successful vibratory plowing of four pockets of infection, DNR removed 112 oak wilt infected trees from the sensitive wet/mesic flatwoods in a matter of days using a helicopter harvest. This kept damage to the sensitive landscape minimal while also allowing for a speedy return of public access to the popular park. The remaining at-risk oaks were treated with fungicide to protect them from succumbing to the disease.

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Oak Wilt

Training is a key focus of the Michigan Department of Natural Resources' mission to control oak wilt. Several workshops were offered in 2017 to help tree care professionals and partners learn to recognize signs of the disease.

A two-day session was held in Windsor, Ontario. Members of the Federal Canadian Food Inspection Agency, the Ministry of Natural Resources and Forestry and representatives from municipalities in southern Ontario attended and discussed Michigan forestry professionals' experience with the disease.



Michigan Department of Natural Resources hosted a training session to teach tree care professionals how to recognize signs of oak wilt.

The demand for oak wilt diagnosis and treatment is too great for public resources to fill the need. Conservation District foresters help address this need, educate private landowners and, where possible, control the spread of oak wilt. DNR forest health staff partnered with the Conservation Districts to provide training they need to detect and control the disease.

The DNR along with the Arboriculture Society of Michigan also offered a new qualification program in October to help tree care professionals become experts at recognizing and treating oak wilt. The 19 participants are listed on the society's website and are available to help landowners with control efforts.

For more oak wilt information and resources please visit the Oak Wilt Coalition website at www.MichiganOakWilt.org

Michigan State University contributed these stories.

By Monique L. Sakalidis

Oak wilt is a vascular disease that affects red and white oaks, but it is particularly damaging to red oaks. It can kill a red oak within six weeks. Oak wilt causes devastating ecosystem damage and is also a blight on the landscape.

Oak wilt is caused by a fungal pathogen that grows inside the xylem, or water-conducting tissues of the tree, and is spread by several species of sap-feeding nitidulid beetles, and to a lesser extent, bark beetles that spread the spores of fungus to healthy trees.

The Michigan Department of Natural Resources has confirmed oak wilt in 56 Michigan counties. Oaks comprise about 10 percent of Michigan's forest. There are approximately 149 million red oak trees across 3.9 million acres of Michigan's private, state, local and federal forests.

We are working on refining Michigan-specific oak wilt control measures. This involves looking at when beetles are most active

and when the fungus is producing spores.

The production of sporulating mats – also known as “pressure pads” -- is a unique and diagnostic feature of the fungus that

Oak wilt pressure pad.

What's in a name?

- The fungus that causes oak wilt, *Bretziella fagacearum*, used to be called *Ceratocystis fagacearum*. The name was changed earlier this year, when scientists reclassified it.
- Sap-feeding nitidulid beetles, which spread the disease from tree to tree, also are known as picnic beetles, because they're drawn to sweet-smelling outdoor party staples such as fruit and beer.

causes oak wilt. By examining pressure pads throughout the year, we can refine when the fungus is producing viable spores and then refine periods of time when there is potential for the disease to spread.

Pressure pads are produced on red oak trees six to eight months after tree death. Mature sporulating mats are noticeable due to their characteristic fermenting odor and the presence of cracks in the bark. The area where the mat is detected can be sampled by the removal of a rectangular section known as a “window.” Additionally, the trunk of dead trees can be tapped with a hammer or similar tool to listen for a hollow sound, which suggests there is a mat below and the region can be sampled.

Twenty-one windows were provided to the Sakalidis lab at Michigan State University by Michigan Department of Natural Resources Forest Health personnel in February 2017 and an additional 11 windows were delivered in November 2017. Of the windows examined, none contained visible asexual or sexual spores, suggesting that even though some of the windows contained open cracks with detectable odors there was little risk of spread during February and October.

We will continue to examine mats throughout 2018 to refine the time periods when the fungus produces viable spores.

Oak Wilt

Olivia Morris and Deborah G. McCullough

Researchers at Michigan State University are trying to identify the high-risk periods when oak trees are especially likely to be infected with oak wilt.

The fungal disease moves through tree vessels that conduct water and generally kills red oak trees within a few weeks or months of infection. It is spread through the roots over short distances, but small sap-feeding beetles can carry it long distances.

Beetles are attracted to the fungus, which produces a smell similar to overripe fruit. Beetles pick up fungal spores as they feed and can introduce the disease to another tree.

Scientists captured more than 1,000 sap-feeding beetles in 2017 and currently are working to identify them. In 2018, they hope to find out which species are most likely to transport oak wilt. They also hope to learn if trees are more vulnerable early in the growing season.



Beetles move the oak wilt fungus as they move from diseased to healthy trees.

Don't spread oak wilt!

- The highest risk of infection occurs April 15-July 15. Avoid pruning or injuring oak trees until they have lost leaves for the winter, typically from November through mid-March.
- If you must prune or remove oaks during the risk period, or have a tree that gets damaged, immediately cover wounds with tree-wound paint or latex-based paint.
- Don't move firewood, especially if it comes from oak wilt-killed trees, as it can harbor the fungus.
- If you suspect your firewood is tainted by oak wilt, cover it with a plastic tarp all the way to the ground, leaving no openings. This keeps beetles away so they can't move spores from the firewood to otherwise healthy trees. Once the firewood has been cut long enough, to the point where all of the bark loosens, the disease can no longer be spread.

Asian Longhorned Beetle

For a seventh consecutive year, surveyors hope they can give DNR state parks and recreation areas a clean bill of health regarding the Asian longhorned beetle.

To date, the insect has not been found in Michigan – but it's nearby, in Ohio.

Adult beetles are large (3/4 to 1-½ inches long) with long black and-white banded antennae. The body is glossy black with irregular white spots. They favor maple trees but also attack horse chestnuts, poplars, willows, elms, birch, and black locusts.



Asian longhorned beetle.

Surveyors target tree species favored by the beetles, looking for signs of infestation. Trees near fire rings are especially vulnerable, as the beetle can emerge from infested firewood.

Asian longhorned beetles are killing thousands of trees in parts of New York, Massachusetts and Ohio. Surveyors use zip codes from these areas to identify campsites whose occupants may have brought infested firewood with them.

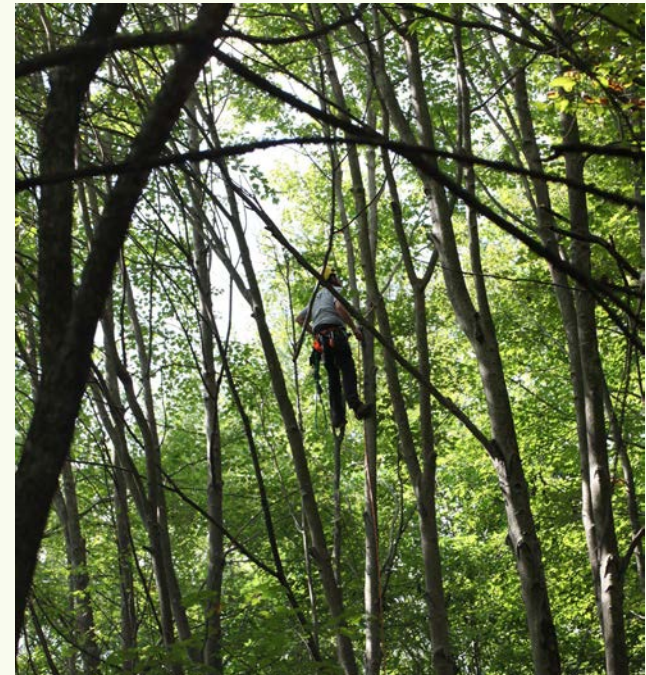
The infestation in Clermont County, Ohio poses a particular risk

to Michigan forests, as it is only a 4-hour drive from the state's southern border. Surveys of nearly 2.5 million trees there have identified over 19,000 that are infested with ALB.

Over 62 square miles of this area in Ohio is under a state quarantine.

The quarantine prohibits movement of firewood, nursery stock, logs and other materials out of the area. The USDA Animal and Plant Health Inspection Service also has placed restrictions on solid wood packing material from China to help reduce the movement of ALB from its native forests.

If you find a beetle you suspect may be an Asian longhorned beetle, or a tree that may be infested, take photos, record the location, collect the beetle(s) in a jar and call 1-800-292-3939 or email MDA-Info@michigan.gov. For more information, visit www.asianlonghornedbeetle.com.



Tree climbers survey for Asian longhorned beetle in Clermont County, Ohio.

Spruce Budworm

Spruce budworm continues to defoliate spruce and fir trees in Michigan's Upper Peninsula and isolated areas in the northeastern Lower Peninsula. Minor expansion into previously uninfested areas occurred in 2017.

Budworm numbers will continue to increase over the next decade. Epidemics of spruce budworm periodically cause extensive defoliation and tree mortality across the northeastern United States and Canada. The outbreaks typically last for 10-15 years.

There is a bright side: the scattered nature of spruce and fir growth in the Lower Peninsula makes it unlikely that large outbreaks of the insect can sustain themselves.

Mature and over-mature balsam fir dominated stands are most susceptible. Infested stands often lose 60 to 80 percent of the fir and 20 to 40 percent of the spruce.



Spruce budworm larva.

Michigan Department of Natural Resources staff continue to identify and harvest newly-defoliated and high-risk mature spruce and fir stands.

About 20 percent of Michigan's spruce and fir resources occur on state forest lands, with 24 percent on federal lands and 56 percent in private hands.

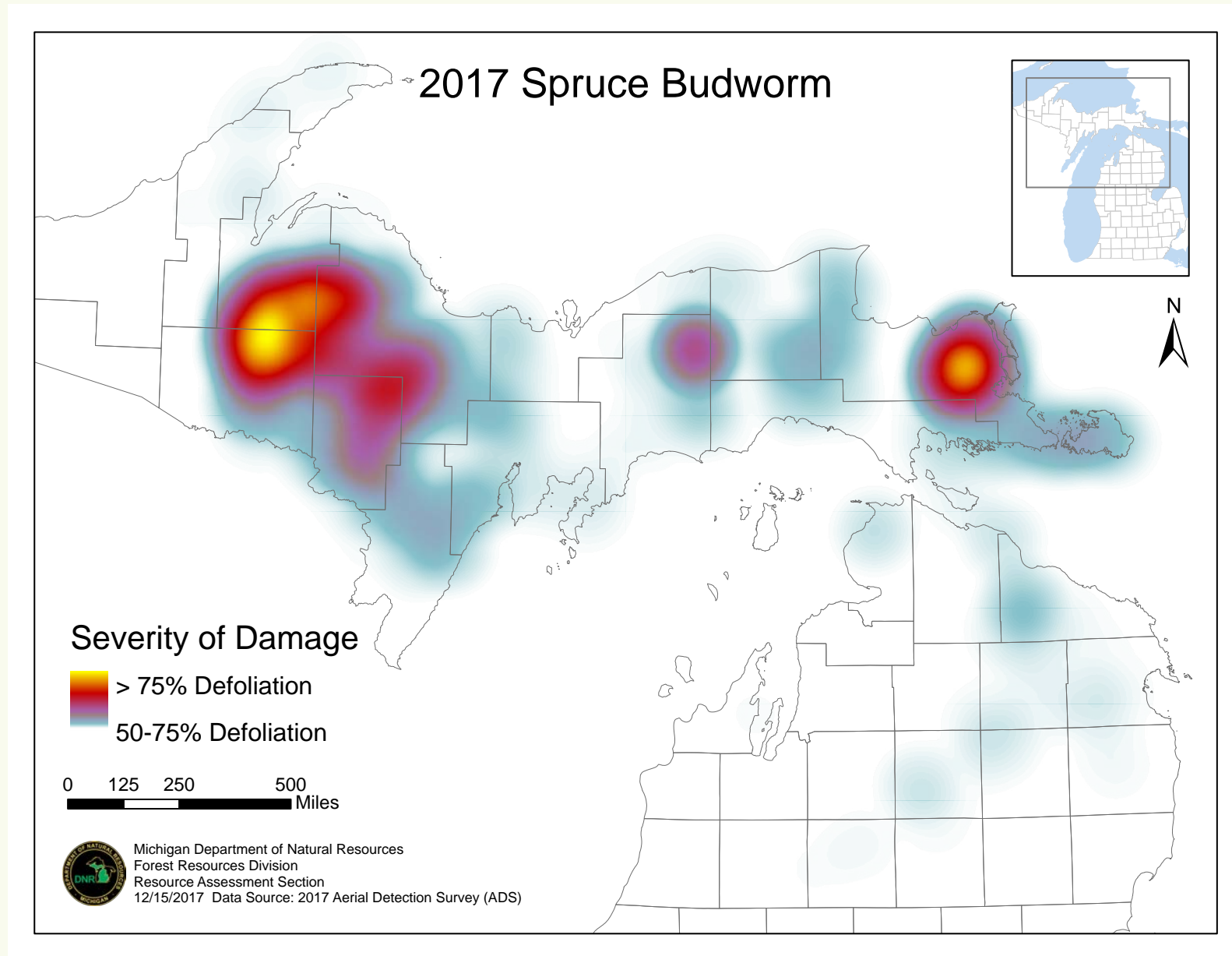


Spruce budworm continued to defoliate spruce and fir trees in 2017.

Management recommendations are to harvest spruce and fir trees when they reach an age of 50 years and to salvage stands with significant budworm damage. Other guidelines include:

- Monitor annual spruce budworm defoliation and presence of mortality from the top to the bottom of the tree.
- Consider harvesting stands with top kill and mortality.
- During an outbreak, prioritize salvage operations by:
 - Harvesting stands with top kill or mortality.
 - Harvesting oldest stands.
 - Harvesting stands with the highest component of balsam fir.
 - Harvesting stands with the highest volume.
 - Recognizing that stands on poor sites may be damaged earlier and to a greater extent.
- When stands cannot be salvaged quickly enough, protect high value stands with registered insecticides.

Spruce Budworm



Heterobasidion Root Disease

Heterobasidion root disease is considered the most destructive fungus in North American forests. It is most commonly found in managed forests. Where freshly cut stumps provide an ideal entry path for airborne spores.

Red pine, white pine and jack pine are especially susceptible. Stands that have been thinned multiple times are at high risk of infection. Proximity to diseased trees that have formed fruiting bodies (mushrooms) increases the likelihood of infection in adjacent areas.

Surveys to identify stands with HRD continue. The emphasis is on managed plantations on state forest land that are likely to be thinned in the next few years. Knowing the location of HRD is critical to managing it effectively. To support this effort, DNR Forest Resources Division has created an online HRD viewer that shows the current confirmed locations of the fungus in Michigan. The viewer includes links to an identification bulletin as well as tools for reporting new or suspected locations of HRD. The viewer also shows a 5-mile advisory zone around each known infection. This is not intended to imply a mandatory treatment zone, but rather an area of increased risk. Plantations that fall within these zones should be evaluated individually prior to treatment to determine management options.

To use the viewer, visit www.michigan.gov/foresthealth and click on "View and report *heterobasidion* root disease locations." The viewer will update in real time as locations are reported.



Top: The spore-producing fruiting bodies of *Heterobasidion Irregularis* formed on a red pine stump in Barry County. **Bottom:** Aerial view of damage suspected to have been caused by *Heterobasidion* root disease near Proud Lake.

Emerald ash borer limiting regeneration in riparian forests

Patrick Engelken and Deborah G. McCullough, Michigan State University

Grasses and sedge seem to be taking over along rivers where green ash once grew before the arrival of the emerald ash borer. In the aftermath of the emerald ash borer invasion of Michigan, many questions have arisen about the response of post-invasion forests. Such questions are especially important for riparian forests that border waterways. Green ash is well-adapted to wet growing conditions and before the ash borer arrived, often grew in dense stands along many streams and rivers. Unfortunately, green ash is a highly preferred host and most overstory green ash in lower Michigan forests have been killed.

We began a study in 2016 to assess effects of the ash borer on vegetation and coarse woody debris in 12 sites bordering first-order streams from southeast to southwest Michigan. We recorded species and size of overstory trees and composition of regeneration within canopy gaps created by ash mortality and in the surrounding forest. We were especially interested in the plant species that are colonizing areas previously dominated by ash trees. The term "invasional meltdown" was coined by ecologists who found that invasion by one species sometimes facilitates invasion by other non-native species.

Continued...

Emerald Ash Borer

The Michigan Department of Agriculture and Rural Development contributed this story.

The western Upper Peninsula counties of Gogebic, Iron and Ontonagon remain the only un-quarantined counties in Michigan at the time of publication. Although quarantined, the UP counties of Menominee and Luce are not known to be infested. The movement of any article regulated by the EAB quarantine from the Lower Peninsula to the UP continues to be prohibited, except with a current and valid Compliance Agreement. Michigan's Emerald Ash Borer Interior State Quarantine was last revised on February 10, 2016.



Damage caused by emerald ash borer.

The quarantine revision exempted firewood that has been certified for the Federal Emerald Ash Borer Quarantine by the United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS), if it is packaged, bears a USDA compliance stamp and is clearly marked with the producer's name and address.

Michigan Department of Agriculture and Rural Development (MDARD) staff continued to renew and issue compliance agreements as necessary. MDARD maintains approximately 50 compliance agreements with receivers, brokers and shippers. Most of these entities are in the UP or otherwise involved with the movement of regulated articles interstate or from the LP into the UP. MDARD staff continued to conduct compliance inspections with EAB compliance agreement holders and write phytosanitary certificates for ash logs and lumber being shipped internationally.

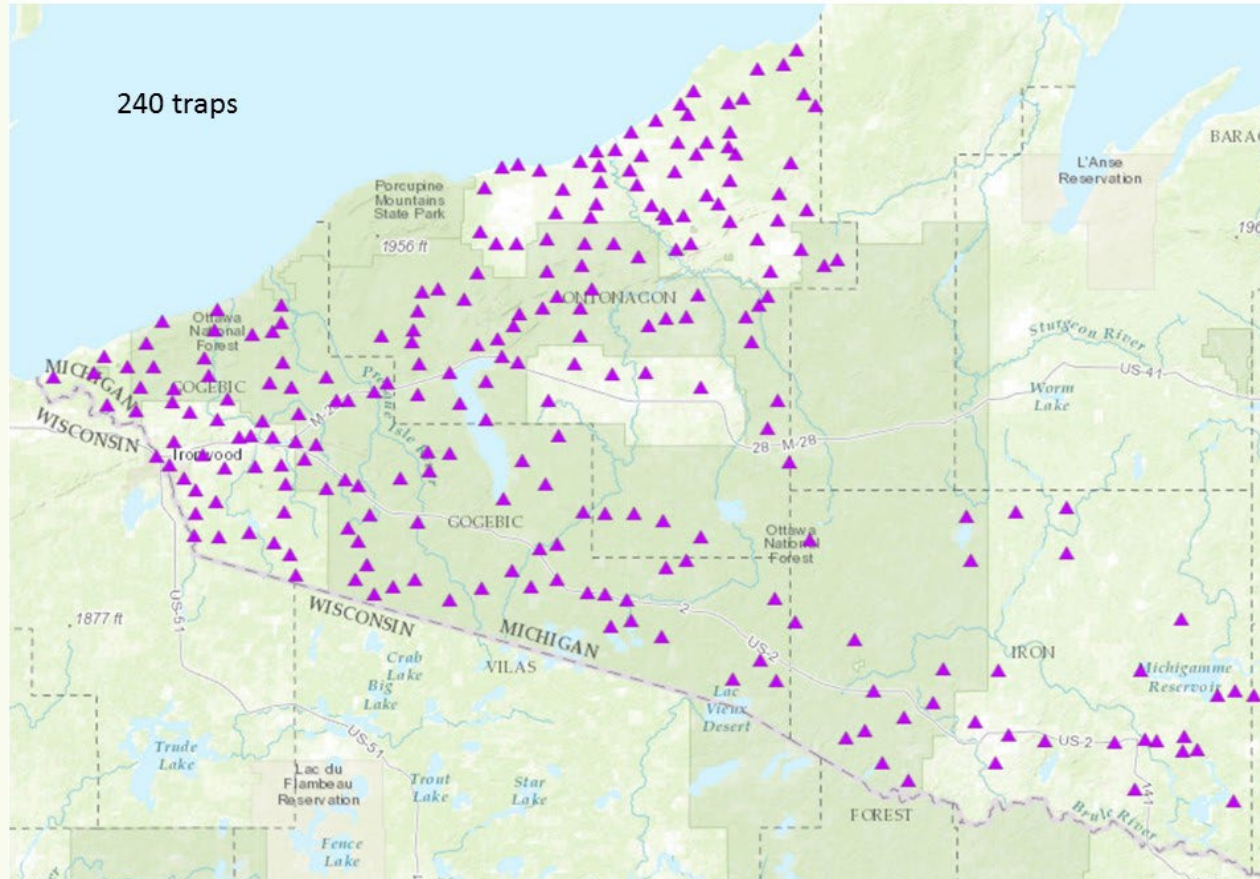
Survey of the non-quarantined counties in Michigan continues to be a critical activity. Knowing where EAB exists in the UP will allow for regulation of areas once they are found to be infested.

The 2017 USDA-APHIS Plant Protection and Quarantine National EAB Survey design included 240 traps in Michigan. The traps were placed in the three counties of the western UP where EAB has yet to be detected. No EAB adults were found on any of the 2017 traps.

For more information about EAB in MI visit: www.michigan.gov/EAB

Emerald Ash Borer

2017 EAB trap Locations – Gogebic, Iron and Ontonagon Counties



Continued...

Our results indicate that sedges and grasses rapidly established in the canopy gaps and are now limiting regeneration of tree species there. Tree seedling density is substantially higher within forests than in gaps, despite the abundant light available in the gaps. Saplings and recruits, which likely germinated before the ash trees were killed, are present in similar densities within canopy gaps and the surrounding forests.

Nearly all invasive plant species in the forested areas are also represented in the canopy gaps, but several invasive plant species were recorded only within gaps and not in the forested areas. Coarse woody debris, consisting mostly of fallen ash trees, was abundant in canopy gaps in the southeastern sites that were invaded by EAB in the early 2000s. In contrast, most dead ash trees are still standing in the more recently invaded canopy gaps in south central and southwest Michigan.

Our survey suggests that many riparian forests may be considerably different following ash borer invasion. Loss of dominant overstory ash trees could provide an opportunity for other tree species to recolonize gaps, but our study indicates many areas are now dominated by sedge meadows. Streams are functionally linked to and heavily rely on adjacent forests for shading and nutrient inputs. Changes in vegetation, structure and woody debris resulting from dead ash trees could subsequently have consequences for aquatic organisms within these streams.

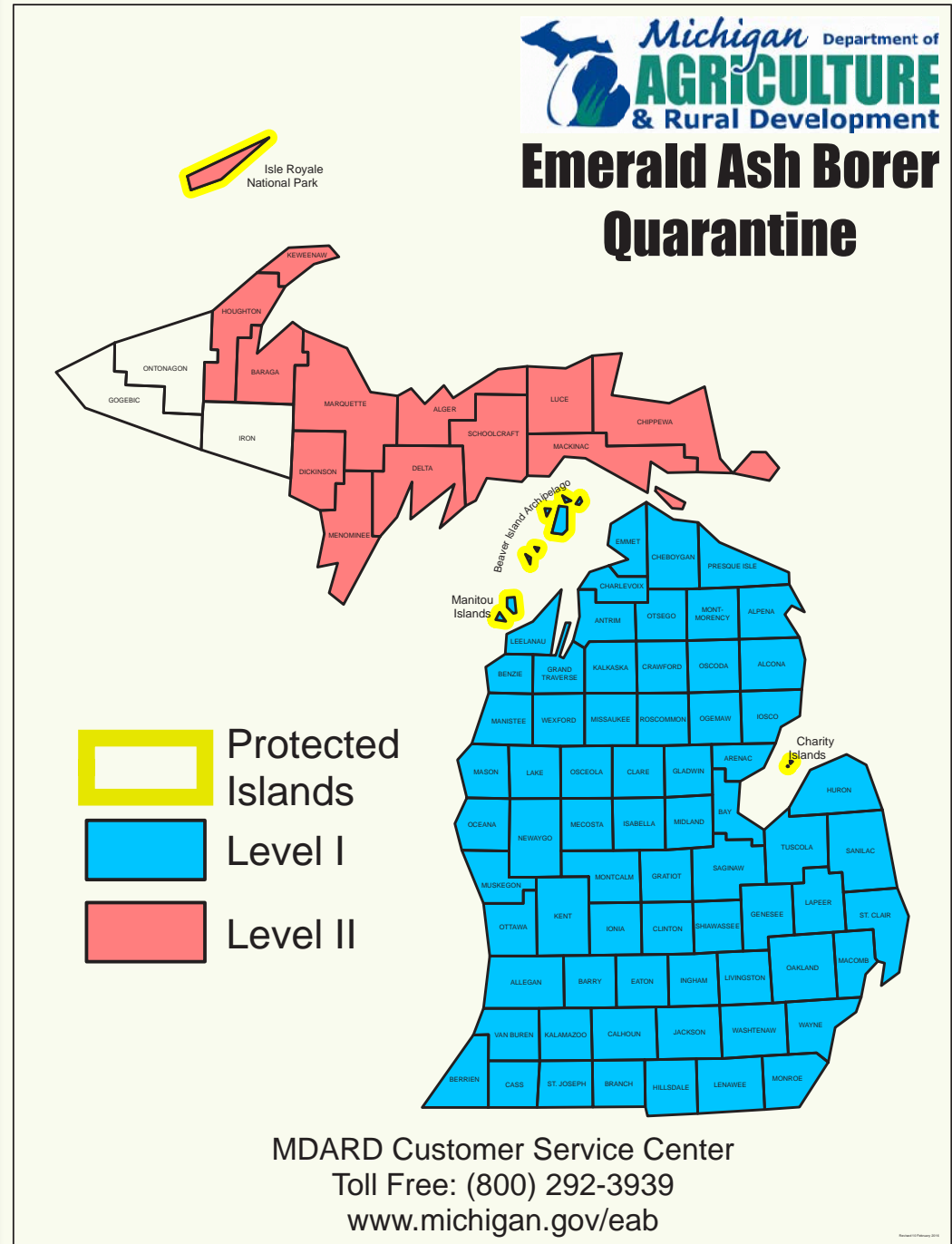
What happens when you stop insecticide treatments after the emerald ash borer population crashes?

Andrew R. Tluczck and Deborah G. McCullough, Michigan State University

In 2006, we began a study to determine if annual applications of dinotefuran (Safari®; basal trunk sprays), imidacloprid trunk injections (Imicide® applied with Mauget® capsules) and imidacloprid basal trunk sprays could protect white ash trees from the emerald ash borer.

When we started the study, ash trees were abundant across much of the large state park in southeastern Michigan where we conducted the trial. We applied the insecticide in mid- to late May each year from 2006 to 2012. Canopy condition of the treated and untreated control trees has been evaluated in midsummer every year from 2006 to 2017. Each fall, we count the number of new exit holes left by emerging EAB adults and the number of new holes resulting from woodpeckers preying on EAB larvae.

Results show the local ash borer population peaked in 2008 and by 2010, most of the green ash trees and many untreated white ash on the site had been killed. Five of the eight untreated control trees in our study died, along with one or two of the trees in each of the three insecticide treatments. However, the EAB population dropped sharply and very few new exit or woodpecker holes were counted in 2012-2014. Trees clearly began to recover and lay new wood over old larval galleries. In 2015, all the trees had healthy canopies and were growing. New exits and woodpecker holes indicate the local ash borer population has increased somewhat over the past two to three years, but most trees still appear healthy. We are continuing to monitor the site to study the dynamics of the insect and the long-term growth and survivability of the remaining white ash trees. Results to date indicate that the frequency of insecticide treatments can be reduced once the infestation has peaked in a given area.



Asian Chestnut Gall Wasp

Michigan State University contributed this story.

Developing an Integrated Management Strategy for Asian Chestnut Gall Wasp

Louise Labbate and Deborah G. McCullough

Michigan's a top producer of chestnuts in the United States, and that means the Asian chestnut gall wasp could pose problems.

The wasp was detected for the first time in Michigan in 2015 in Berrien County.



Asian chestnut gall wasp.

This insect, which is native to China, has become established in at least 11 states since it was discovered in Georgia in 1974. Galls caused by larval feeding reduce shoot growth and can substantially reduce nut production.

This invasive pest is likely to be most important in commercial chestnut orchards. Cover sprays of insecticides can reduce insect density in commercial orchards, but are likely to harm populations of native insects as well.

A larval parasitoid - an insect parasitic only in its immature larval stage - native to China was

imported and released in Georgia as biocontrol in 1977. It has since been introduced in other states but appears to disperse naturally as wasp infestation spreads.

We began a project in 2017 to monitor wasp development, abundance and distribution in five infested Michigan orchards and to determine if the introduced parasitoid was present.

We found parasitized wasp larvae in four of the five orchards, indicating the Chinese parasitoid is not only present, but dispersing naturally.

Yellow sticky cards were used to capture adult wasps and monitor distribution at the five infested orchards. We also placed sticky cards in six additional orchards that were not known to be infested as of 2016. Adult wasps were trapped in 10 of the 11 sites, including an orchard that was 45 miles from the nearest known infestation. We plan to continue research in 2018 and use results to develop guidelines for this new invader.

Forest Tent Caterpillar

If you are walking through the woods and notice small caterpillars spinning down on silken threads, it could be the Forest Tent Caterpillar, an insect native to the eastern United States and Canada that is cycling back around.

Population outbreaks occur every 8-12 years in Michigan's hardwood forests, with the last outbreak occurring in 2009-2010. Several small areas of heavy defoliation were reported in the eastern Upper Peninsula and northern Lower Peninsula in 2016, building in 2017. Outbreaks usually last two to three years, so continued population buildup is anticipated into 2018-2019.

Young larvae emerge in the spring and begin feeding on newly developing leaves, often stripping the tree of foliage. Defoliated trees will respond with a second flush of leaves in late June and early July. This second growth is often stunted and brownish in color and

further depletes the tree's stored energy reserves.



Forest tent caterpillars.

The Forest Tent Caterpillar does not actually form a tent, but spins silken threads and mats on the upper trunk of the tree. Caterpillars will gather in large colonies when at rest or during periods of molting. As the caterpillars increase in size, it is common to see these large groups gathering lower on the tree.



Defoliation caused by forest tent caterpillar.

During large outbreaks, caterpillars often move in search of food sources as they defoliate entire forests. This has earned them the nickname of "armyworms" in some areas.

As a native insect, many natural enemies have evolved alongside the forest tent caterpillar. These predators, parasites and natural pathogens will respond to the increase in caterpillar population and will begin to bring the outbreak under control.

Of interest in Michigan is a large non-biting fly known as the "friendly fly." It deposits eggs on the cocoon of the caterpillar. Its larvae feed on and kill the pupae. Both caterpillars and the flies can be a nuisance to home owners during outbreaks.

Gypsy Moth

In 2017, caterpillar activity in the northeastern Lower Peninsula – particularly Alcona, Alpena, Iosco, Oscoda and Ogemaw Counties – caused significant defoliation to oak and, in some cases, aspen. Isolated pockets of moderate to heavy defoliation were also confirmed in Allegan County.

An exotic insect introduced into Michigan in the early 1950s, gypsy moth caused extensive defoliation across the northern Lower Peninsula in the late 1980s and early 1990s. During its heyday, gypsy moth defoliation approached 1 million acres in a single season.



Gypsy moth caterpillar infestation.

While not native to Michigan forests, gypsy moth has become “naturalized” in recent years as many native insect parasites and predators have learned to use gypsy moth larvae as a food source.

In addition, two pathogens – one a virus, the other a fungus – can be lethal to gypsy moth populations in years with cool, wet spring weather.

While gypsy moth continues to periodically outbreak in oak and aspen forests, these outbreaks tend to be more localized. Outbreaks are shorter, too, as natural enemies reduce caterpillar numbers and egg viability.



The gypsy moth caterpillar is not native to Michigan forests, but native insects and predators have learned to use it as a food source.

Lecanium Scale

If you noticed a lot of sap dripping from your trees last summer, or the growth of black sooty mold, you might have a lecanium scale infestation.

Lecanium scales are small, spherical insects typically found on small tree branches and twigs. They exude honeydew (a sugary substance that can look like sap) as they feed on the tree.

Populations of lecanium scale remained unexpectedly high for a third year in Michigan in 2017. Repeated heavy Lecanium scale infestations can kill smaller branches in the tree's canopy. Crown dieback, reduced vigor and leaf development was observed in pin and black oak in the northern Lower Peninsula. Both oak and maple trees are affected. Ground surveys indicated that Lecanium scale was a contributing factor.

Maple trees appear to be fending off branch dieback more successfully; however with persistently high scale populations, these stands are likely suffering from reduced overall vigor and growth loss.



A fungus attacks a lecanium scale insect and forms a hard outer shell with spike-like fruiting bodies.

Natural enemies, especially lady beetles and tiny parasitic wasps, usually keep scale populations below damaging numbers. Pesticides are not recommended in order to avoid killing predators and parasites.



Lecanium scale infestation.

In Michigan, the increased appearance of another natural enemy may be a sign that Lecanium scale populations will begin to return to normal levels next year. An entomopathogenic fungus (and a member of the Cordyceps family) that attacks Lecanium scale has become established and is spreading through the population. The fungus invades the body of scale, killing it and forming a hard-outer shell with spike-like fruiting bodies which release spores.

Red headed Pine Sawfly



Redheaded pine sawfly collapsed in 2017 after damaging young red and jack pine plantations for several years. Natural enemies and diseases brought the population back to normal levels and eliminated the need for control measures.

The redheaded pine sawfly defoliates young two-needle pines. Plantations less than 15 feet tall are most susceptible. Heaviest infestations commonly occur on pines under stress, particularly those at the edges of hardwood forests, on poor soils and where there is heavy competitive vegetation. The sawfly prefers edge trees.

Repeated defoliation can cause top-kill, forking and tree mortality. A single moderate-to heavy-defoliation stunts height growth of infested trees. Complete defoliation in a single year can kill red pine and jack pine.

The larvae feed in colonies containing a few to over a hundred larvae. Early damage is identifiable by the reddish-brown, straw-like remains of needles partially consumed by the young larvae.

Older larvae consume the entire needle, generally stripping a branch of all its foliage before feeding on another.

Early detection and rapid response are the keys to protecting infested sites. Monitoring egg laying and early larval development in June and early July is important in successfully controlling populations.



Top: Redheaded pine sawfly larvae infestation. **Bottom left:** Redheaded pine sawfly eggs. **Bottom right:** Redheaded pine sawfly lays eggs.

Spruce decline

Michigan State University contributed this story.

By Monique L. Sakalidis and Keumchul Shin

Colorado blue spruce is a popular species planted as landscape trees and in Christmas tree production. It tolerates a wide variety of soil and climate conditions, and is generally considered resistant to pests and diseases.

Since 2006 spruce trees in the Lower Peninsula have been declining. This is noticeable as an initial loss of needles followed by lower branch dieback on the north side of the tree. These symptoms gradually progress upward, moving around to the sunny side of the trees and to points where trees are not touching. The top of the tree rarely dies, however trees are often removed



Healthy and diseased Colorado blue spruce.

prior to this point as one method of mitigating disease.

Shallow branch cankers are visible in the phloem of infected trees. Tests revealed that fungi were associated with nearly all of the needle cast and branch death

symptoms found on mature, landscaped Colorado blue spruce, white spruce, Norway spruce and arborvitae hedges. Prior to the initial reports of declining Colorado blue in landscape and Christmas trees, the fungus was only known as a nursery disease of Colorado blue spruce.



Colorado blue spruce seedlings.

MSU researchers discovered two species of the fungus *Diaporthe* were associated with spruce decline – one a well-known pathogen and the other new to science. Scientists are analyzing the fungi.

Scientists also inoculated Colorado blue spruce seedlings with the fungi. Early results indicate differences in the severity levels between the two species. Trials will continue in 2018.

Thousand Cankers Disease



Michigan DNR staff are on the lookout for walnut twig beetle after thousand cankers disease was identified in Indiana.

Thousand cankers disease is spread when walnut twig beetles feed on black walnut tree branches. The disease kills small areas of tissue around each feeding site, resulting in a canker. As more cankers form, branches die, and over time, entire trees can die.

Forest Resources and Parks and Recreation division staff deployed pheromone lures at 10 state parks, from Warren Dunes in southwest Michigan to Mayberry State park in metro Detroit. The traps were monitored every other week for 12 weeks. Some traps were deployed in early May, while others were set up later to extend the sampling season.

Samples collected during the 2017 field season have not been sorted and examined for the presence of thousand cankers disease or walnut twig beetle at the time of this publication.



Walnut twig beetles feed on black walnut branches, which forms cankers.

Thousand Cankers Disease

The Michigan Department of Agriculture and Rural Development contributed this story.

The Michigan Department of Agriculture and Rural Development (MDARD) established a state quarantine in 2010 to protect Michigan's walnut trees from Thousand cankers disease. The quarantine resulted from reports of the death of hundreds of black walnut trees in Colorado and detection of the disease in the eastern U.S. In the past seven years, researchers and regulatory officials have acquired new information about thousand cankers disease. MDARD initiated a review of the quarantine in 2017 and updated it based on current information.

Here's what's changing:

- The host plant list will be expanded to include wingnut as well as walnut species.
- The regulated area will be expanded to include Arizona, California, Colorado, Idaho, Maryland, Nevada, New Mexico, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Utah, Virginia and Washington.
- Regulated articles can be shipped from non-infested counties in regulated states provided that the state maintains an interior quarantine.
- Hardwood firewood heat treated for 60 minutes at 140 degrees Fahrenheit may be shipped into Michigan from regulated areas.
- Walnut veneer will be exempt.
- Walnut logs, walnut lumber and hardwood firewood originating from non-infested areas and moving through a regulated area may be able to be shipped into Michigan provided that the articles remained in the regulated area less than 48 hours.

Next steps:

MDARD posted a draft revised quarantine for comments in September and the comment period closed October 20. The final quarantine is posted online at www.michigan.gov/pestquarantines.



Tree affected by thousand cankers disease.

White Pine Dieback

Michigan State University contributed this story.



Symptomatic eastern white pine with flagging branches in Michigan.

By Katherine Minnix and Monique L. Sakalidis

Reports of declining white pine have been increasing in the Great Lakes States and northeastern US for the past decade. Unusual mortality and branch death occurred along the Au Sable and Manistee Rivers in the north central Lower Peninsula in Michigan. Saplings and recruits primarily were affected, but mature trees now are exhibiting symptoms. In August 2017, an infected white pine site was discovered in Lake County.

In Michigan, symptomatic trees exhibit sunken red cankers on the trunk and branches, sometimes under large lichens. A scale insect is often found in close proximity to the cankers. These symptoms are characteristic of a disease caused by a fungal pathogen that has been affecting white pine in New England and in the Southern Appalachians. New Hampshire has reported damage to sapwood in mature white pine. However, the cankers found in Michigan rarely go deeper than the phloem.

In October 2016, eyelash-shaped fruiting bodies similar to those the fungus produces were observed on a diseased white pine from Crawford County. Since then, numerous fruiting bodies have been found on the bark above these cankers. Early genetic

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analysis of a fungal culture suggests that the Michigan pathogen is different, but closely related to the pathogen found in the east. Surveys will be conducted in 2018 to determine the distribution of this disease, identify site factors that predict disease and collect more samples to help characterize the fungal pathogen.



Left: Reddish cankers visible on symptomatic eastern white pine in Michigan. Credit James Jacobs. Right: The fruiting bodies associated with cankers on eastern white pine in Michigan.

White Pine Weevil

Michigan State University contributed this story

Katherine Minnix and Deborah McCullough

If you see a tree with a shepherd's crook appearance, it may be infected with white pine weevil. The native forest insect colonizes white pine, jack pine and many spruce species. The shepherd's crook is caused by larvae feeding under the bark of the top, center shoot of the tree – also known as the terminal leader.

Unlike many forest insects that attack stressed trees, the weevils prefer to colonize stout leaders on vigorous, young trees. They are especially fond of trees growing in full or nearly full sunlight. When the terminal leader is killed, other shoots compete for dominance, leading to crooked or forked trunks. These defects diminish the value of the trees for timber. They also can affect growth rates and trees' ability to compete with other species for light.

From 1998-2000, researchers from Michigan State University, the Michigan Department of Natural Resources and the United States Forest Service assessed ways to minimize the effects of white pine weevil on white pine regeneration.

Researchers currently are revisiting these sites to assess pine survival, radial growth and defects. In three areas, pine are growing with or beneath hardwood overstories, providing an opportunity to evaluate effects of competition in mixed species stands.



Forked branching in white pine caused by white pine weevil.

Forest Pest Outreach

More than 725 tree care professionals were trained in 2017 to look for and report insects and diseases that are threatening Michigan's forests.

Funding from the United States Department of Agriculture Farm Bill enabled the Michigan Department of Agriculture and Rural Development to offer training for personnel from utility companies, tree planting organizations, campgrounds, logging companies, firewood dealers and more.

Participants learned to recognize signs of Asian longhorned beetle, hemlock and balsam woolly adelgid, thousand cankers disease, walnut twig beetle, spotted lantern fly, beech bark disease, oak wilt and other high priority tree pests. Training also included:

- pest life history, potential hosts, and impact of high priority exotic pests;
- distinguishing pests from native look-alikes;
- where and how to look for pest life stages and recognize symptoms of infestation;
- methods for reporting possible pest sightings
- eradication and management strategies implemented in the U.S. and Canada;
- risks of transporting live trees, logs and firewood;
- current quarantine restrictions on live trees, logs, and firewood.

The funding also supported printing of forest pest educational materials. MDARD distributed more than 21,000 Forest Pest Alerts for pests like Asian longhorned beetle, hemlock and balsam woolly adelgids, thousand cankers disease, beech bark and oak wilt.

Forest Pest Alert

Asian Longhorned Beetle

(Anoplophora glabripennis)



- ✓ Larvae feed in tunnels (called galleries) in the wood of tree branches and trunks.
- ✓ Maple trees are the Asian longhorned beetle's (ALB) favorite host. More than 1 billion maple trees grow in Michigan. ALB can attack and kill many other tree species, including poplar, willow, sycamore, and horse chestnut.
- ✓ ALB populations are known to be present in areas of southern Ohio, Massachusetts and New York.
- ✓ ALB can be transported into new areas in logs and firewood.
- ✓ If you see a suspect tree or beetle, take photos, record the location, collect any suspect beetles in a jar and report it to the following:

1-800-292-3939 | MDA-Info@michigan.gov

www.misin.msu.edu



Learn More:
www.michigan.gov/exoticpests
www.asianlonghornedbeetle.com



Don't Move Firewood!

Michigan Invasive Species Grant Program

More than \$3.5 million in grants went to help prevent and control invasive species, thanks to the Michigan Invasive Species Grant Program. The program is administered by the Michigan departments of Natural Resources, Environmental Quality and Agriculture and Rural Development.

Grant amounts ranged from approximately \$35,000 to \$350,000, and recipients included nonprofit organizations, universities, conservation districts and other units of government. The grant program seeks to strengthen efforts to educate the public about invasive species and monitor and control their spread. Applicants were asked to match at least 10 percent of the total project cost.

A portion of the funding supported Cooperative Invasive Species Management Areas (CISMAs), which work to prevent, survey, control and eradicate invasive species across the state.

Funding was used to:

- Treat a recently discovered outbreak of oak wilt in Belle Isle's rare 200-acre wet-mesic flatwood forest.
- Refine oak wilt control and detection measures (Michigan State University).
- Support hemlock woolly adelgid surveys, risk assessments and management strategies (Michigan State University).
- Educate teachers about invasive species and prevent their release (Wayne State University).

Invasive species pose significant risk to Michigan's world-class natural resources, and funding through the grant program is vital to our continued fight against these invaders. These grants aid our partners in their efforts to battle invasive species. Their hard work goes a long way toward protecting our natural resources, as well



Foresters conduct training on oak wilt diagnosis and treatment. Advancement of these skills and techniques are the focus of a project funded by the 2017 Michigan Invasive Species Grant Program.

as the many recreational and economic opportunities tied to Michigan's woods and waters.

Learn more about invasive species in Michigan at www.michigan.gov/invasivespecies.

This project was funded in whole or in part through a grant awarded by the USDA, Forest Service, Northeastern Area State and Private Forestry.

The USDA is an equal opportunity provider and employer.