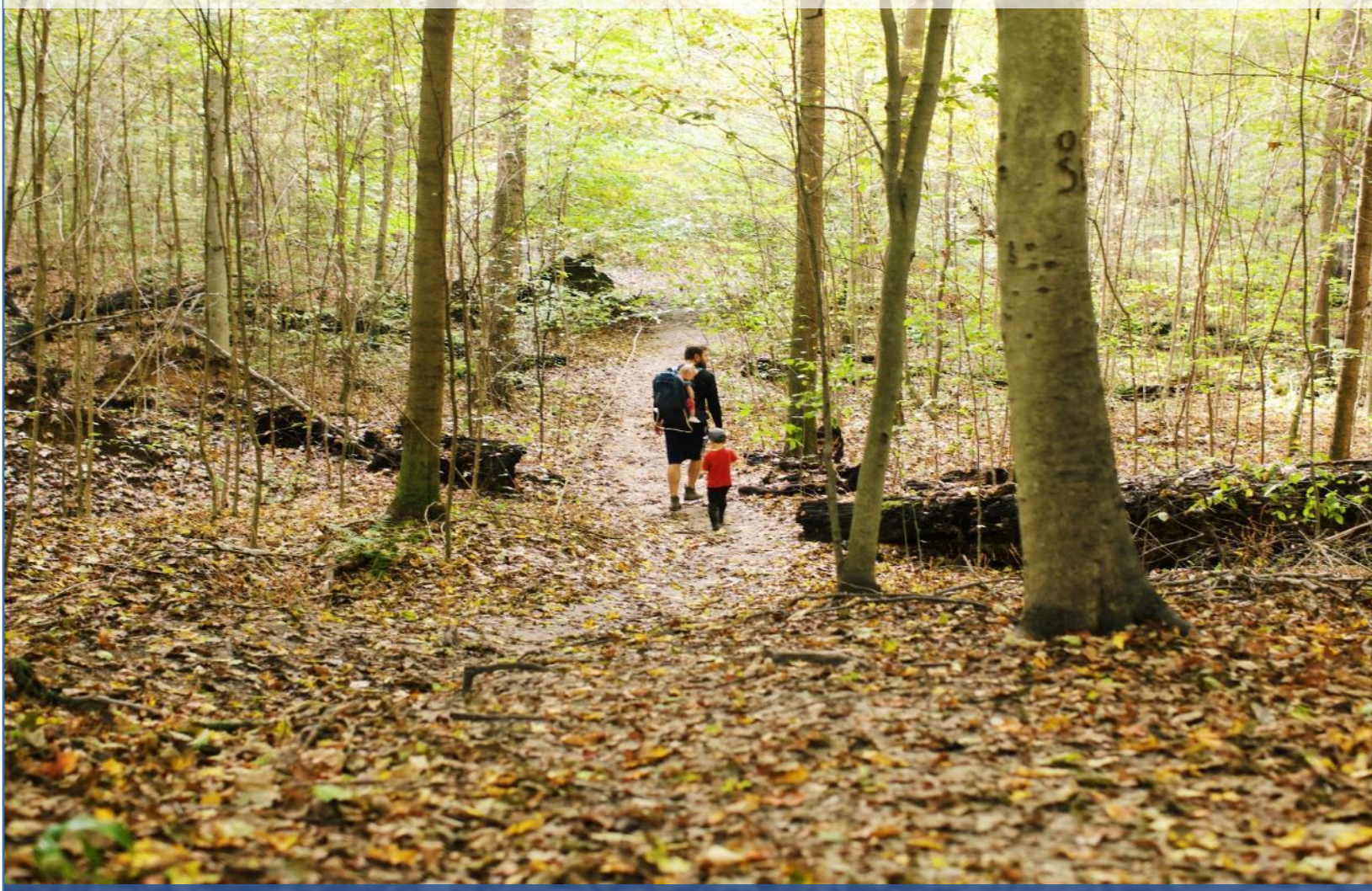
Michigan 2022
Forest Health Highlights



Michigan Department of Natural Resources
Forest Resources Division

Introduction

During 2022, beech leaf disease was confirmed for the first time in Michigan. The forest health team in the Michigan Department of Natural Resources knew that beech leaf disease was on the doorstep, with reports of it in Ohio and Ontario, and had been preparing for years.

The team also knows that an informed public is a valuable ally in spotting and battling forest pests. So when a landowner in St. Clair County noticed puckered leaves on a tree and reported it, team members were ready to identify and mobilize against this new disease.

The first spotted lanternfly population was found in Michigan this year as well. The Michigan Department of Agriculture and Rural Development has taken the lead on addressing this pest, supported by the DNR Forest Health Program. Spotted lanternfly can kill or damage a wide range of fruit, ornamental and woody plants, particularly vineyards, orchards and hops. Several tree species may also be at risk due to this pest.

Teamwork among residents and local and federal authorities is a priority for forest health, and efforts continuing in 2022 included:

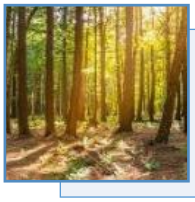
- Surveying and treating trees for hemlock woolly adelgid in west Michigan.
- Coordinating efforts to battle oak wilt disease and oak decline in Michigan, and continuing outreach to help protect oak trees from infection.
- Conducting forester field training to slow Heterobasidion root disease in red pine plantations.
- Working to breed trees resistant to beech bark and Dutch elm diseases and emerald ash borer.

In 2023, the forest health team will continue to coordinate efforts to contain, eradicate or mitigate impacts of pests, diseases and invasive plants, and create plans to help address new problems that arise.

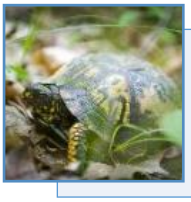
This essential work helps protect Michigan's forests and the environmental, economic and community benefits they provide.

Yours in cooperation,

Jeff Stampfly, Michigan DNR Forest Resources Division Chief and State Forester



20 million acres of forests, 4 million managed by DNR



Diverse forest ecosystems, habitats and species

$22 billion forest products industry

Environmental and health benefits

Contents

Bridging the gap

Forest health team translates the latest research into on-the-ground management techniques

Maintaining healthy forests in Michigan continues to challenge managers as new forest health concerns arise. It's vital that the DNR Forest Health Program stays on top of the latest research to adapt best management strategies to effectively mitigate forest health concerns while preserving Michigan forests.

Forest health program staff maintains institutional knowledge of biology, prevention, survey, monitoring and management of pests, diseases and invasive plants.

In addition, the program evaluates new ways of addressing forest health issues and new threats on the horizon. Forest health staff members participate in educational opportunities with a variety of partners. Online resources including research journals, pest alerts and forest health reports from other jurisdictions also help staff keep up to date.

Summer oak wilt training event.

Among other training opportunities in 2022, forest health staffers attended several training sessions to learn about current and future threats and connect with other forest health specialists dealing with similar issues. Staff traveled to Minnesota for the annual North Central Forest Pest Workshop and to a Great Lakes Forest Fire Compact-sponsored program in Ohio for field-focused training on beech leaf disease, Asian longhorned beetle and spotted lanternfly. They also traveled to New Hampshire for the annual Hemlock Woolly Adelgid Manager's Meeting.

Ohio beech leaf disease training.

Training of partners continues to be a critical component of detecting and mitigating forest health concerns in Michigan. This year, forest health staff trained and updated a variety of internal and external partners working on forest health threats in Michigan. These training sessions shared survey, identification and management strategies for hemlock woolly adelgid, oak wilt, Heterobasidion root disease, beech leaf disease and others.

Continued training, opportunities to view these threats in person and discussions with colleagues are critical to bridge the gap between the research and best management strategies. This also allows us to address the growing concerns of native and invasives pests in a changing climate.

Surveys and observations

Heavy seed crops stress trees

In June, reports of dying red maples began to come in from across the Upper Peninsula and local areas in the northern Lower Peninsula. Upon closer inspection, affected trees had a very heavy seed crop and few leaves. As the seeds turned tan or reddish brown, it gave the appearance that the tree was rapidly dying.

Some of these trees continued to have a thin crown through the summer, but it does not necessarily mean they will die.

A lot of energy is required to generate a heavy seed crop, and it comes at the expense of leaves.

A heavy seed crop produced by this maple tree creates stress.

High-value yard trees affected by the heavy seed crop should be monitored and watered during any extended summer dry spells in 2023 to ensure good recovery.

Many species will only produce heavy seed crops on a periodic basis. Weather often plays a role, with important factors being late frosts, drought or other variables that may impact pollination or tree health. It also may be an adaptation to prevent predators that feed on seeds from building up and overwhelming the amount of viable seed, thereby preventing successful reproduction of the tree species. It also allows trees to rebuild the energy reserves required to produce large seed crops.

Seed production often appears coordinated on a regional basis suggesting regionwide variables may play a role in heavy seed crop years.

Left: Browning and thinning are observed in a tree that produced many seeds.

Common 2022 native pest observations

Eastern larch beetle

This native beetle feeds on tamarack trees, boring a hole into the tree, making channels on the inside of the bark and sapwood, which weakens or kills the tree. Infected tamarack trees often produce large amounts of resin and lose bark, and their needles yellow. This bark beetle prefers trees that are stressed, especially by drought, frost damage, flooding, damage from the larch casebearer moth or age. The insect can reproduce on logging debris or dead trees. Recently, this pest has become a continual issue in some states. In Michigan, it typically occurs in shorter outbreaks that begin with tree stress. When the eastern larch beetle is active, it is important to harvest before tamaracks become age-stressed. The last big Michigan outbreak began in 2008; the beetle is currently less active. *Image by Steve Katovich, USDA Forest Service.*

Spruce budworm

This insect continues to damage white spruce and balsam fir. The budworm partially or fully consumes the needles and cones of a tree, causing the needles to dry out, then turn a reddish-brown color and die. Impacted stands are noticeable from a distance, as the entire stand turns a rust color. Overmature stands of fir and spruce are most vulnerable. In addition, stands with balsam fir tend to be hit hardest. It often takes back-to-back infestations to kill a tree, however. Spruce budworm is cyclical; in Michigan outbreaks occur every 30-50 years, and each outbreak lasts 10 to 15 years. Populations in Michigan are currently cycling downward. Spruce and fir trees should be harvested every 50-60 years to avoid losses from spruce budworm. Budworm populations have impacted most of the susceptible spruce and fir stands in the Upper Peninsula, but there were still small, isolated damage pockets that continued to occur in 2022.

Lecanium scale

This native insect is found on a range of hosts including oak, maple, ornamental fruit trees and many other trees and shrubs. It is a soft-bodied, brown scale insect about one-sixth to one-eighth of an inch in size. These sap-sucking insects excrete a sticky substance called honeydew. The honeydew can often attract other insects and/or a sooty mold. Drought and other stressors will contribute to increases in lecanium scale population; however, the scale is often kept in check by other predators and parasites. Large infestations can cause branch dieback and leaf drop. Small infestations can be trimmed out. After several years of high populations, lecanium scale populations crash as predator and parasite populations build.

Fall webworm

Fall webworm has a wide range of deciduous tree hosts throughout North America, but it prefers cottonwood, walnut and cherry. In late summer into fall, this native insect produces a big, showy cluster of webbing on the branches of trees and shrubs. The dramatic web encompasses foliage, and caterpillars consume the leaves inside the webbing. Deciduous trees often recover from this leaf loss, called defoliation, with no long-term effects because most of the damage occurs just before leaves are shed in the fall. In addition, many parasites and predators naturally keep the fall webworm in check. To treat, prune out webs and burn them or simply take a stick, tear apart the webbing and collect caterpillars in a bucket of soapy water. *Image by Steve Katovich, USDA Forest Service.*

Key 2022 forest health issues

Beech leaf disease discovered in Michigan

watchlist species

Michigan forest health staff members have been watching beech leaf disease for several years as it spread in nearby Ontario and Ohio.

As part of their work to identify and prioritize potential invasive forest insects and diseases, they began surveying for beech leaf disease in southeast Michigan in 2019. The disease was added to Michigan's Invasive Species Watch List in 2021 to increase awareness.

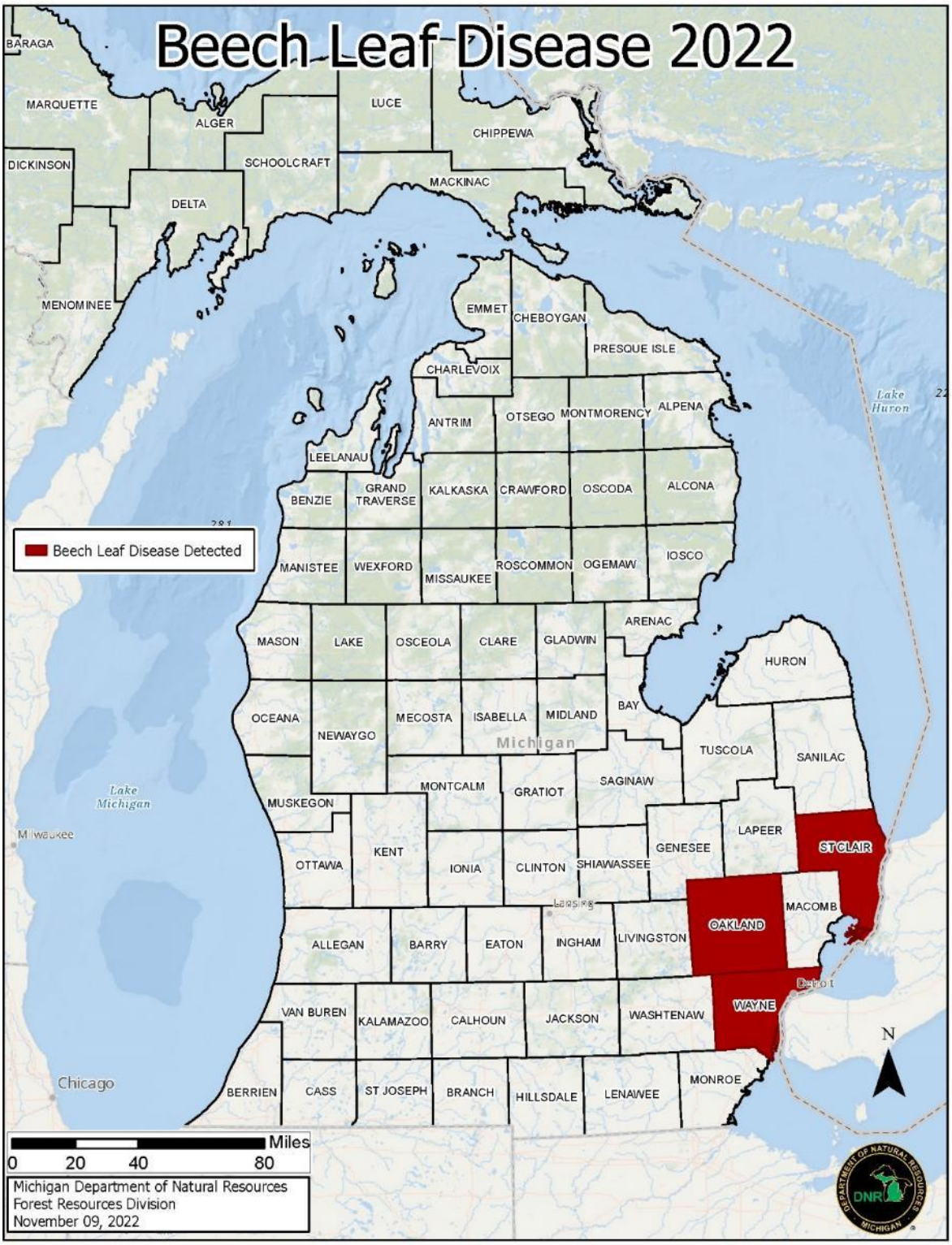
Thickened leaf tissue and dark banding are commonly observed signs of beech leaf disease.

This year, the disease was detected for the first time in Michigan. An alert private landowner in St. Clair County noticed symptoms of the disease on beech trees, took photos and submitted a report to the DNR forest health program and to the Midwest Invasive Species Information Network (MISIN). Samples were collected and tested to confirm the presence of the disease.

Michigan has approximately 37 million American beech trees larger than 5 inches in diameter at breast height. Recognized by their smooth bark, they are an important component of our forests, providing wildlife with shelter and food in the form of nuts, particularly in areas of the state without many oak trees. American beech trees are also important to Michigan's economy as they are used for a variety of furniture, flooring and utensils. Unfortunately, beech trees were already struggling in Michigan due to beech bark disease, first identified in 2000. Many mature beech trees have been lost. Beech leaf disease further threatens these trees.

While most mature beech trees are killed by beech bark disease as the trunk becomes infected, many beech trees regenerate and grow through root sprouts before they die. Beech leaf disease appears to affect the buds and foliage of both mature and young, regenerating beech trees. It takes four years or less to kill small understory trees and six to 10 years to kill mature trees in some areas. Trees weakened by leaf damage become more susceptible to other diseases.

Beech leaf disease was discovered in Ohio in 2012. In subsequent years, extensive surveys have been conducted in northeastern states. As of late 2022, the disease has been confirmed in nine states and Ontario, including in Oakland, St. Clair and Wayne counties in southeast Michigan. Detection at multiple locations and advanced symptom progression suggests the disease is well-established in areas of these counties. However, American beech is not as common in southeast Michigan as it is in other areas of the state, which may help limit impacts to the current infested area. Several detections have occurred on ornamental landscape specimens in urban areas, where European and Asian beech species are also susceptible.



Beech leaf disease has been detected in three southeast Michigan counties: St. Clair, Oakland and Wayne.

A forest health specialist takes photos and samples for analysis.

Initial beech leaf disease symptoms are dark, slightly thickened bands between leaf veins. As symptoms become more severe, leaves may appear to be distorted or puckered and may drop early. Eventually, canopies become sparse with small, yellow or dark, leathery, puckered or swollen leaves.

Symptoms may get progressively worse from one year to the next. Over time, nearby trees may develop symptoms. Understory trees are typically affected first and to a greater degree initially than larger overstory trees.

Beech leaf disease is associated with a microscopic worm, *Litylenchus crenatae*, a nematode that enters and overwinters in leaf buds, causing damage to leaf tissue. Research is ongoing to determine whether other micro-organisms are involved in symptom development, how beech leaf disease spreads, how it affects trees and how long it takes before visible symptoms are formed. The disease does appear to be well-established by the time detection occurs. Eradication is not a viable option, as the disease appears to spread beyond where symptoms can be detected.

There isn't enough data on possible treatments to make effective recommendations. However, researchers in Ohio report that treatment with phosphite products may promote tree health and reduce symptom development. Other products are being tested.

What can you do to help beech trees?

Don't move beech nursery stock and other beech materials, such as fallen leaves, from locations near infestations. Use hand sanitizer after handling infested materials and use boot brushes to clean footwear.

Become aware of beech leaf disease symptoms and less serious but similar-looking pests and diseases. Visit Michigan.gov/Invasives/id-report/disease/beech-leaf-disease for more information.
Report potentially infested trees: Take closeup and full photos of the tree, record the location and choose one of the following reporting options:

- Email DNR-FRD-Forest-Health@Michigan.gov.
- Use the Midwest Invasive Species Information Network (MISIN) online reporting tool.
- Download the MISIN smartphone app and report from your phone – MISIN.MSU.edu/Apps/#Home.

Invasive spotted lanternfly discovered in Oakland County

***Lycorma delicatula*, watchlist species**

Spotted lanternfly arrived in Pennsylvania in 2014 and has now been detected in 13 states across the Midwest and East Coast.

The unintentional movement of egg masses and other life stages of the insect on shipping containers, recreational vehicles, nursery stock and other vectors likely accounts for the invasive insect's quick spread.

In early August 2022, Michigan State University Extension reported a potential detection of spotted lanternfly to the Michigan Department of Agriculture and Rural Development.

The report was quickly verified, initiating a multi-agency survey that established the presence of the insect on a single, county-owned property in Oakland County.

Adult spotted lanternfly with colorful, speckled wings. Image from Michigan Department of Agriculture and Rural Development.

A delimitation survey established the extent of the infestation at roughly 15 acres. A detection survey conducted within a 1-mile radius found no evidence of the pest beyond the original location.

Hatched egg masses found on tree stock at an on-site nursery suggest spotted lanternfly arrived in Michigan on nursery stock imported from New Jersey. The presence of hatched egg masses on nearby tree of heaven, a favored host tree for the insect, indicated the infestation is at least 2 years old.

Response

In August and September 2022, Oakland County treated accessible trees of heaven within the infested area using imidacloprid and dinotefuran. Smaller trees of heaven (2 inches or less) were cut and treated with Garlon 4. Trees of heaven in an area difficult to access due to unsafe terrain will be treated later. A fall-to-winter egg mass survey is planned, and an ovicide treatment is being considered.

Two nurseries within the immediate vicinity of the infestation have been placed under compliance agreements that allow for the continued safe sale and transport of stock. The compliance agreements stipulate training, inspection, treatment and record-keeping. Trace-forward investigations from the infestation source found hatched egg masses on three pieces of nursery stock that had been transplanted to other locations within Oakland County. Site inspections found no evidence of infestation at these locations.

Identification

Nymphs: Spotted lanternflies pass through four immature stages before reaching the adult life stage. In the first three life stages, the insects look like small black beetles with white spots and no wings. In the fourth stage, they change in appearance slightly, adding red patterns to their bodies.

Adults: Adult spotted lanternflies are roughly 1 inch long. Their folded wings are gray to brown with black spots. Open wings reveal a yellow and black abdomen and bright red hind wings with black spots transitioning to black and white bands at the edge.

Egg masses: When first laid, egg masses look like fresh putty or chewing gum. As egg masses age, they crack and begin to look like dried mud or mortar. The color of egg masses varies from light tan to dark gray or brown. Each egg mass can contain 30 to 50 eggs.

The fourth immature stage of the spotted lanternfly.

Adult spotted lanternfly. Images from MDARD.

Host plants

The list of hosts the spotted lanternfly can feed on seems to be ever-growing. Michigan's fruit and nursery crops, such as grapes, are at risk. Fruit plantations and vineyards may see a reduction in crops or vine dieback. Among our native trees, black walnut, oak, willow, maple and sycamore may help the lanternfly complete its life cycle. However, in many cases forests are not significantly affected by feeding. The spotted lanternfly causes direct damage by sucking sap from host plants and secreting large amounts of a sugar-rich, sticky liquid called honeydew. This honeydew and the resulting black, sooty mold can foul surfaces and kill surrounding plants. Feeding can leave host plants weakened and susceptible to secondary infection.

If you suspect you have observed a spotted lanternfly in Michigan, consult the Invasive Species Program spotted lanternfly webpage to find more information. Take photos, record the location and email MDA-Info@Michigan.gov or report using the Eyes in the Field app at Michigan.gov/EyesInTheField.

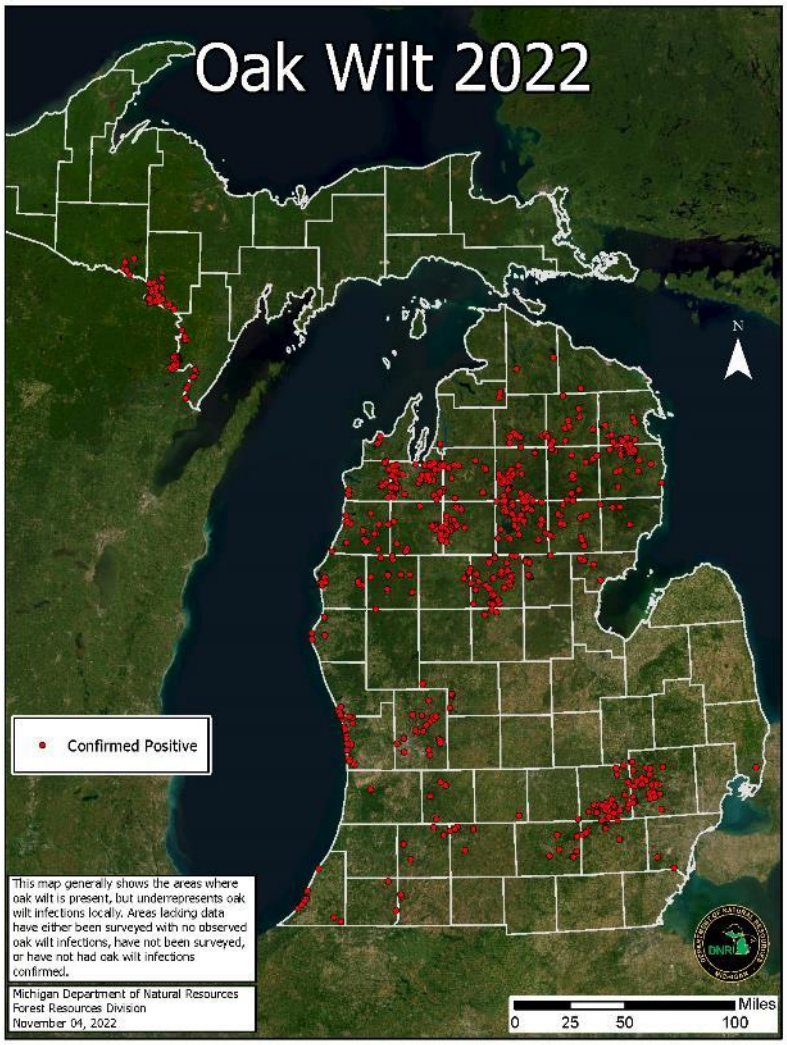
Updates in the fight against oak wilt disease

Bretziella fagacearum

Michigan forests, woodlots and residential landscapes lose thousands of oak trees each year due to the invasive fungal disease oak wilt.

Red oak species are especially vulnerable to oak wilt and may die within weeks of developing symptoms. The fungus spreads into the roots, where it eventually moves to nearby trees through connected root systems. When untreated, groups of adjacent red oak trees can die within a few years. This creates an oak wilt "epicenter," or pocket of dead and infected trees.

Oak wilt was first identified in 1944 and was confirmed at several locations in southern Michigan beginning in the early 1950s. However, the extent of the disease in Michigan didn't become apparent until the 1980s.



Dots indicate confirmed oak wilt locations, primarily along the Michigan-Wisconsin border and much of the Lower Peninsula.

Decaying oak wilt fungal pressure pad.

Today, the disease is widespread across much of the Lower Peninsula and along the Wisconsin border in the Upper Peninsula in southeast Iron, Dickinson and Menominee counties. The potential for oak wilt to spread into new areas of the state continues, including to locations where beech trees have been lost due to beech bark disease. This increases the importance of protecting the oak resource as a tree that provides mast, or nuts, that feed wildlife populations and offer other benefits.

Over the past 70 years, early detection and treatment efforts across Michigan have protected many oak trees that would otherwise have been killed.

Awareness campaigns are focused on ideal pruning times and not moving firewood. They highlight risks of infection through oak wounds from April 15 to July 15 to help reduce local infection and the threat of spreading oak wilt through infested wood to help limit long-distance disease spread. In 2022, the DNR Forest Health Program conducted four intensive oak wilt field training sessions to provide information on biology, diagnostics and management of oak wilt to DNR and Michigan Department of Agriculture and Rural Development staff.

Staffers attend an oak wilt field training session.

Over the past several years, the DNR Forest Health Program has prioritized locations where USDA Forest Service Oak Wilt Suppression Program funds are used to have the biggest impact in protecting Michigan's oak forests. A vibratory plow is used to sever tree roots connected underground and prevent the spread of the disease from infected trees to healthy ones nearby. While the technique has been effective, it has limitations. Rocky ground, steep hillsides or residential areas with buried utility lines are a few examples of where trenching is not always feasible. In addition, the vibratory plow is expensive to rent and not always available for use during the critical fall treatment period. DNR's Parks and Recreation Division recently purchased a vibratory plow through the Happy Little Trees Program supported by Bob Ross International. This purchase will help the DNR to manage priority oak wilt sites.

In the past few years, the DNR Forest Health Program began testing an herbicide-based technique in oak wilt management that may reduce costs, increase the number of oak wilt epicenters we can treat annually and be used where trenching is not possible and that has shown promise in other states. The herbicide treatment relies on killing root systems before the fungus can invade and spread to adjacent trees. Healthy oak trees surrounding an epicenter are girdled by making two cuts around the trunk near the tree base, through the bark and into the wood. Triclopyr herbicide is applied to the girdle. Research suggests it may take multiple years for the root systems to die. Consequently, the technique is in trials on a limited basis at a few sites while we monitor the results and collect data on how well it works. We do not currently recommend the technique for widespread use until more data becomes available.

See the DNR's interactive online oak wilt map for confirmed and suspected locations. It is important to note that many oak wilt infections go undetected, and the map does not reflect the full extent of oak wilt in Michigan. Visit Michigan.gov/ForestHealth and click on "View and report oak wilt locations."

Need help? A variety of programs address the threat of oak wilt and oak decline on private land:

- MDARD Forestry Assistance Program foresters help private landowners with oak wilt and oak decline outreach, confirmation and treatment.
- The DNR's Forest Health Program provides oak wilt advice; email DNR-FRD-Forest-Health@Michigan.gov.
- Michigan State University Extension can provide valuable insight on oak wilt.
- Private arborists offer fee-based oak wilt assistance. View a list of oak wilt-trained arborists.

Partners continue battle against hemlock woolly adelgid

***Adelges tsugae*, watchlist species**

Millions of hemlock trees at risk; partners work to stall the tiny, deadly adelgid

A branch with white hemlock woolly adelgid ovisacs.

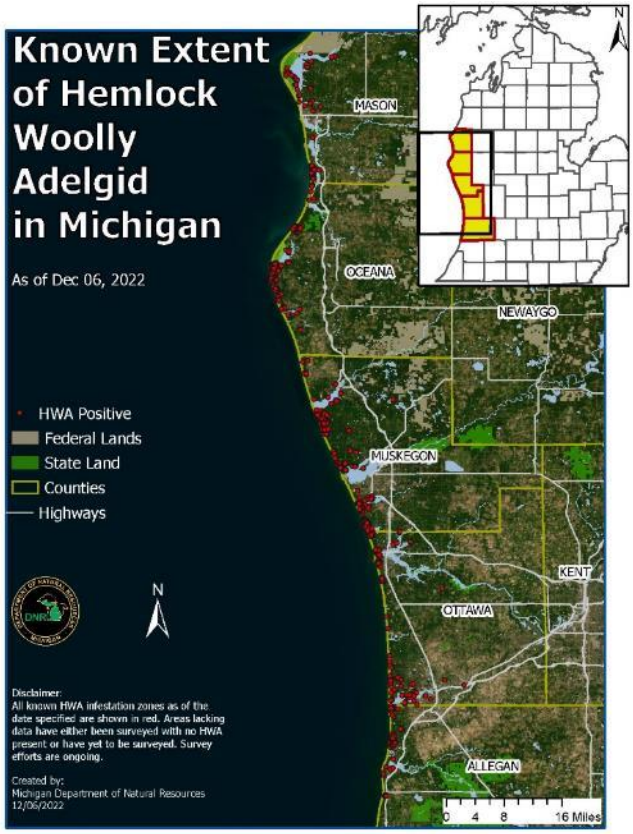
Michigan is home to over 176 million hemlock trees that are now at risk due to an invasive insect called the hemlock woolly adelgid.

Hemlocks are important in Michigan, especially in dense stands, because they stabilize sand dunes, offer wildlife food and habitat, and play a significant role in keeping cold-water trout streams cold.

Hemlock woolly adelgid, a tiny forest pest known as HWA, feeds on the sap of hemlock trees at the base of the needles. After trees are infested for four to 10 years, it is typical to see trees decline in health or die. HWA was first detected in hemlock trees in the eastern United States in 1951 when it was discovered in Virginia. Since then, HWA has spread, killing millions of eastern and Carolina hemlocks.

Today, infestations span 110 miles of shoreline along Lake Michigan in critical dune habitat. Densities along the Lake Michigan shoreline vary from a single infested tree to thousands of infested hemlocks. Infestations are contained by natural barriers on three sides. Hemlock trees are sparse to nonexistent to the south or east of the current infestation, moving away from lake or river corridors, and to the west lies Lake Michigan.

This allows forest health staff to focus containment efforts on the northern extent of the HWA infestation, directly protecting Michigan's hemlock resource to the north. Extensive surveys continue to maintain confidence relating to HWA distribution in Michigan. Surveys in high-risk areas in the northern Lower Peninsula and the Upper Peninsula are completed on a periodic basis to ensure populations of HWA are not establishing elsewhere.



A map shows the extent of mapped HWA infestations, located in coastal areas of western lower Michigan.

Efforts to keep the pest away from Michigan extend back decades. In 2001, the Michigan Department of Agriculture and Rural Development established an exterior quarantine before HWA was known to occur in the state. Current populations in Michigan were introduced through infested nursery stock planted in landscapes either before the quarantine or in violation of the quarantine.

A survey crew inspects hemlocks, looking for adelgid signs.

HWA was first detected in Michigan in 2006, with the full extent of establishment recognized in 2016. Surveys and public awareness made it clear that introductions along Lake Michigan had gone unnoticed for years. In 2017, pockets of hemlock woolly adelgid were observed in western Ottawa County, including the first detection on state-managed land at P.J. Hoffmaster State Park. In 2017 an internal quarantine was implemented, and revised in 2020, to restrict hemlock plant material movement out of and within the five infested counties – Allegan, Mason, Muskegon, Oceana and Ottawa.

The growing epidemic in Michigan prompted formation of a coordinated statewide strategy to manage hemlock woolly adelgid. Written in 2017 and revised in 2021, partners came together as the Michigan HWA Coordinating Committee and finalized the statewide strategy, focusing on high-priority areas such as prevention, detection, management, outreach and research.

Collaboration with researchers and staff has been vital to effectively address Michigan's unique situation. The coordinating committee continues to pull from new information gathered from within and outside the state by agencies, professionals and researchers working on HWA. Managers from northeastern states and Canadian provinces and researchers convene annually to summarize and discuss new or improved tools to help mitigate HWA. This year, the eighth annual Hemlock Woolly Adelgid Program Managers' Meeting was held in Portsmouth, New Hampshire. These meetings have helped Michigan forest health staff collect and share information that has significantly improved understanding of HWA and how to adapt strategies to Michigan's specific circumstances.

Hemlock woolly adelgid collaborators

Federal: USDA Forest Service Forest Health Protection, Huron-Manistee National Forest and Northern Research Station, and the Pictured Rocks and Sleeping Bear Dunes national lakeshores.

State: Michigan departments of Agriculture and Rural Development; Environment, Great Lakes, and Energy; and Natural Resources.

Local cooperative invasive species management areas and affiliated organizations:
Many partners work together in a coordinated effort to address HWA. Those most involved this year include CAKE, Lake to Lake, North Country, SW x SW, Three Shores and West Michigan CISMAs, Northwest Michigan Invasive Species Network and Wild Rivers Invasive Species Coalition.

University partners: Grand Valley State University, Michigan State University and Michigan Technological University.

Hemlock woolly adelgid survey efforts

Understanding HWA's location in Michigan helps determine where efforts are needed to effectively manage the pest and allows us to make more informed decisions to efficiently use resources. Survey efforts since 2016 continue to be vital for the success of Michigan's statewide strategy and have primarily focused on high-risk areas of infestation along Lake Michigan's shoreline in the Lower and Upper peninsulas. Today, about 12% of the 1,058 miles of Lake Michigan shoreline in Michigan are known to be infested with HWA. In addition, no established HWA populations have been detected in the northern Lower or Upper peninsulas, which includes the bulk of Michigan' hemlock trees.

Surveys in 2022 identified movement of HWA into additional areas near established populations. In November 2022, the first detection of HWA on the north side of Hamlin Lake was confirmed, which prompted the first treatment of HWA on national forest land in Michigan. Some brighter news came from Benzie County, where HWA was found at Sleeping Bear Dunes National Lakeshore in February 2021. After extensive surveys, no additional HWA has been detected in the county after the known infestation was removed and destroyed and remaining hemlock were treated.

Responsibilities for hemlock woolly adelgid detection survey and monitoring were divided into three groups: federal and state land, state park land, and private and local public land. In 2018, the Forest Health Program within the DNR's Forest Resources Division created a response team to detect, manage and monitor pests and diseases in Michigan forests. Its primary objective is to help implement the HWA statewide strategy, with a focus on surveying federal and state land, as well as treatment and outreach.

The DNR's Parks and Recreation Division leads HWA efforts on state park land. The division has established a year-round Civilian Conservation Corps forest health crew to focus on surveys and treatment. Lastly, private and local public land has been covered by many partners, but primarily by local Cooperative Invasive Species Management Area crews. More recently, Sleeping Bear Dunes and Pictured Rocks national lakeshores have put together HWA crews to help survey their lands.

Survey acres by partner: Winter 2021-2022

Agency	Detection survey acres	Counties surveyed
Sleeping Bear Dunes and Pictured Rocks National Lakeshores	1,937	6
Michigan DNR Forest Resources Division*	342	6
Michigan DNR Parks and Recreation Division	2,860	19
Local Cooperative Invasive Species Management Area organizations	2,227	12
Agency totals**	7,582	21

*Survey was predominantly focused on Manistee National Forest and Nordhouse Dunes Wilderness Area, where USDA Forest Service staff helped with survey.

**Total survey acres includes additional partner numbers not listed in the table.

Hemlock woolly adelgid treatment efforts

Data collected through survey efforts continue to be a cornerstone of the effort to effectively contain or slow the spread of HWA. Data are reviewed by treatment crews across all ownerships to collaboratively and strategically treat HWA in the northern extent of HWA infestations and to target source populations farther south. Both DNR and CISMA staff conducted treatments on state and private land during 2022. Note that more recent detections will be reviewed and treated in 2023. For example, the new find just north of Hamlin Lake will be targeted for treatment in the spring of 2023.

Treatment data by partner

Agency	2022 hemlocks	2022 inches	2022 acres	Total hemlocks	Total inches	Total acres
Sleeping Bear Dunes National Lakeshore	64	591	3	64	591	3
Michigan DNR Forest Resources Division	869	9,477	480	3,288	38,179	910
Michigan DNR Parks and Recreation Division	6,741	53,783	122	47,531	316,780	2,342
Local conservation districts	43,080	267,849	1,512	118,362	765,940	6,052
Agency totals	50,754	331,700	2,117	169,245	1,121,490	9,307

Summary

Michigan hemlock resources continue to be at risk from hemlock woolly adelgid even after a total of 9,307 acres and 169,245 trees have been treated over the last five years. However, most of Michigan's hemlock trees remain uninfested and many miles away from established HWA populations. In addition, recent studies looking at the insect's cold hardiness suggest that many areas in the Upper Peninsula would not be favorable for HWA to thrive. Further studies on HWA and climate change impacts may shed more light on this topic. Funding from the Michigan Invasive Species Grant Program, Great Lake Restoration Initiative, Recreation Passport (state park user fees) and fundraising efforts supported by Bob Ross International continue to support these HWA efforts.

If landowners suspect hemlock woolly adelgid is present on their property, they should report it immediately. Report suspected hemlock woolly adelgid infestations through the Midwest Invasive Species Information Network, available online at MISIN.MSU.edu. If an infestation is confirmed, landowners can take action to treat trees. It is important to know which insecticides and application methods work best.

Surveys help find, mitigate Heterobasidion root disease

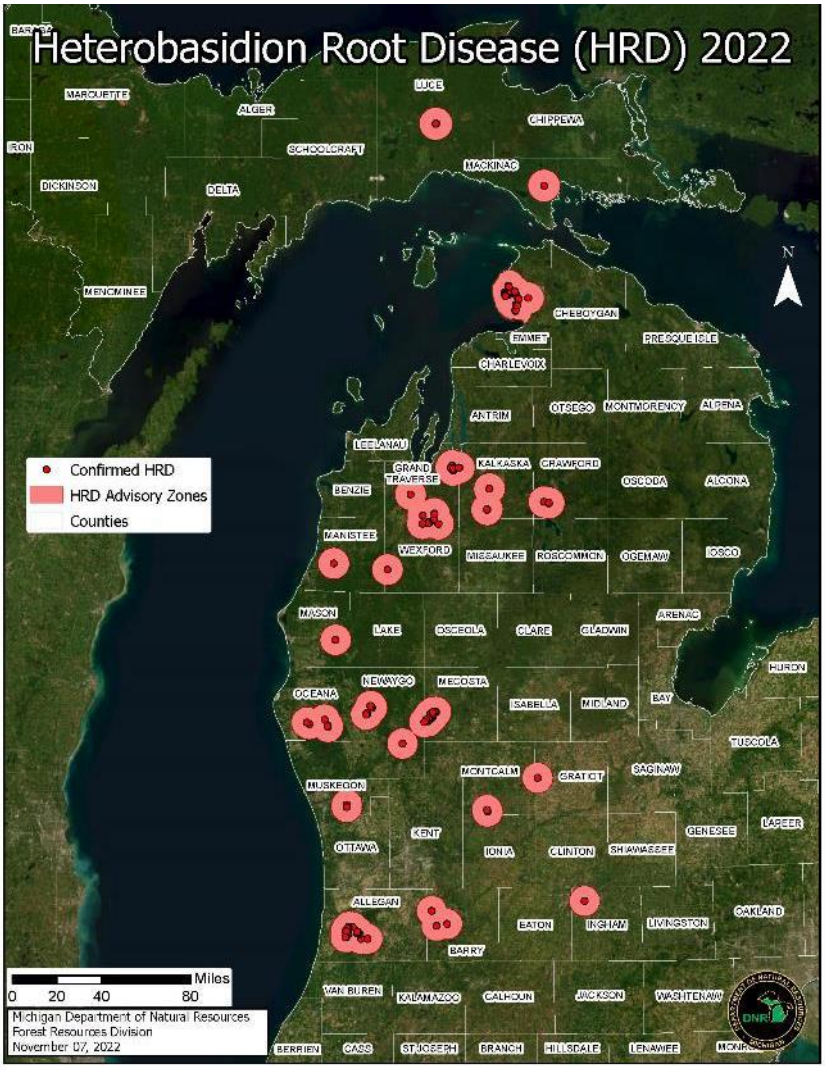
Heterobasidion irregulare

Addressing Heterobasidion root disease is critical to protecting the managed red pine resource in Michigan. HRD is one of the most economically and environmentally destructive fungal pathogens of forests in North America.

Ignoring this threat could limit our ability to grow red pine. Consequently, the forest health program staff prioritizes surveying for the disease in high-risk locations. Staff members survey up to 4,500 acres a year for this disease.

By knowing where this disease is present, we can implement management practices that protect areas from infection.

HRD, caused by the fungus *Heterobasidion irregulare*, is thought to be native to Michigan. Besides red pine, white and jack pine, spruce and several other conifers are susceptible to HRD infections.



Dots on a map indicate recorded HRD locations, primarily located in the eastern Upper Peninsula and western Lower Peninsula.

Other than red pine, we have not observed infection in plantings of these species in Michigan, partly because these species are not extensively thinned. Actively thinning or harvesting opens pathways for HRD to spread into new areas. That puts actively managed stands at a much higher risk for infection than unmanaged stands. Recent detections in Michigan have occurred in actively managed red pine plantations at least five years after thinning operations, although crown symptoms typically appear three to eight years after a thinning.

Ongoing survey activities confirm HRD in 16 Lower Peninsula counties and two counties in the eastern Upper Peninsula. In 2022, we had no new county detections, although the disease was found at additional locations in counties with previous detections.

Many detections occur when pockets of dead pine are identified during aerial survey activities or after reports from field staff or reports from private foresters and the public through the Forest Health HRD online viewer.

Infections occur when fungal spores land on freshly cut stumps. After the spores germinate, the fungus slowly spreads through roots that grow together, connecting adjacent trees. HRD spreads 3-6 feet per year through these root grafts and will slowly lead to a pocket of dead trees. Once infected, HRD may persist as long as stump and root material remains. Over time, the impact becomes significant, particularly after thinning operations near existing infections when fresh stumps are not protected.

DNR training on causes of red pine death.

HRD is most easily identified in the fall when the fruiting bodies, or mushroom-like growths, are more obvious at the base of affected stumps and trees. The fruiting bodies are leathery brown on top and white on the bottom, with elongated pores or tiny holes, not gills like many other common fungi have. The risk of infection to nearby areas through fresh-cut stump surfaces increases with the abundance of fruiting bodies and spore production. Once the disease is present, it may become impossible to grow susceptible species on that site for several decades or more.

Currently, on state-owned land, an "advisory zone" of 5 miles around known HRD sites is considered at increased risk for infection. DNR forest health staff assesses red pine plantations scheduled to be treated or cut within the zone. If the risk of HRD infection is determined to be high, restrictions are placed on the sale of timber. These sale specifications include winter logging from Jan. 1 to March 31, when spore production is suppressed, or a stump treatment to prevent new infections. When stump treatment is required, one of two products (Cellu-Treat or RotStop C) must be applied to stumps after cutting. In the Huron Manistee National Forest, restrictions are placed on all red pine timber sales within 25 miles of known infection sites. These restrictions in the national forest include winter logging from Jan. 1 to Feb. 28 or stump treatment. Treatment should also be considered on private lands in high-risk locations to protect the red pine resource into the future. It's important to note that stump treatment will not prevent existing pockets of infection from continuing to spread.

An interactive, online HRD map shows confirmed locations of the fungus in Michigan and the 5-mile advisory zone as well as locations where surveys did not detect HRD. The map also includes an identification bulletin and tools for reporting new or suspected locations of the disease for follow-up by DNR forest health staff.

To use the map, visit Michigan.gov/ForestHealth and enter information into the interactive map using the "View and report Heterobasidion root disease locations" link. Reporting potential infection areas helps protect forests for future generations.

Insects

Stay on the lookout for Asian longhorned beetle

***Anoplophora glabripennis*, watchlist species**

Asian longhorned beetle has yet to be detected in Michigan, but it could pose a threat to Michigan's trees and economy.

The black and white, spotted Asian longhorned beetle.

The beetle, known as ALB, is roughly 1.5 inches long and glossy black with white spots. As its name suggests, the beetle has long black and white antennas that are 1.5-2.5 times the size of its body. ALB has a wide range of trees it feeds and completes its life cycle on, including maple, elm, birch, poplar and more.

It's more likely people will notice signs of Asian longhorned beetle damage to trees than the insect itself. A good time to check for signs of ALB is during the fall, after leaves are down but before snow cover. Another good time: when large branches break from declining maple trees. The larvae tunnel inside the heartwood of the tree, causing heavy structural damage. The beetle's exit holes are about the size of a pencil and perfectly round. Other visible symptoms of the beetle are dime-sized, chewed depressions in the bark of the tree where eggs have been laid. These are called oviposition pits. Decline in tree health coupled with these visible symptoms would warrant contacting a professional to take a closer look.

The closest known infestation in the U.S. is in Clermont County, just southeast of Cincinnati in southwest Ohio, discovered in 2011. Eradication efforts have been successful elsewhere in several locations in North America, and experts anticipate eradication will eventually be successful in Ohio. However, these efforts can cost millions annually, even for Ohio's infestation of just 57 square miles. The most recent detection was in Charleston County, South Carolina in 2020, where eradication efforts are just beginning. Both infestations went undetected for about eight years, allowing the beetle to establish itself and become a monumental threat to the community and environment, causing millions of dollars in damage. The best way to prevent this in Michigan is through prevention and early detection. Stay informed, report suspected infestations and don't move untreated firewood long distances. Moving firewood and packing materials are major concerns for dispersing Asian longhorned beetle. DNR staff and volunteers raise awareness while conducting annual surveys in state parks and recreation areas.

Observant and knowledgeable residents will be critical in helping detect and report this pest early. If you find anything you suspect may be an Asian longhorned beetle, collect the beetle if you can and report your finding immediately to 1-800-292-3939 or MDA-Info@Michigan.gov. Store the specimen in a container or zip-lock bag and place it in the freezer until a specialist can look at it.

First large outbreak of native jack pine budworm pest recorded since 2015

Choristoneura pinus

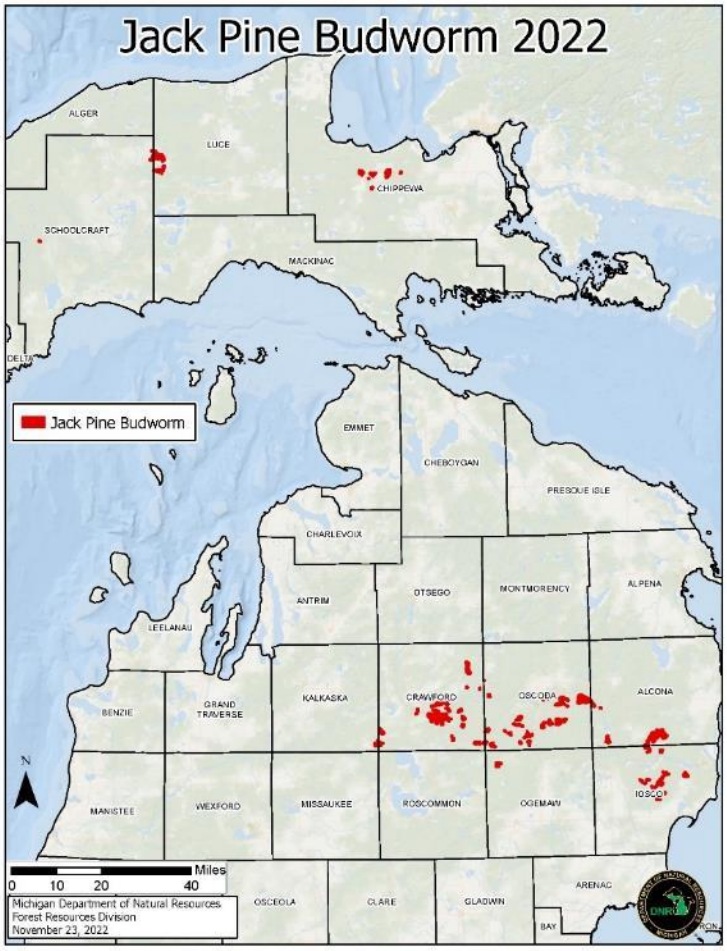
Jack pine budworm, *Choristoneura pinus*, is an insect native to Michigan that cycles through periodic outbreaks every six to 12 years. Outbreaks are typically short, building for two to four years before collapsing to low levels.

Severe impacts can kill trees or lead to top-dieback in older, overmature jack pine stands. This creates fuel for intense wildfires.

Jack pine older than 45 years growing on sandy sites and suffering from stressors such as drought are most vulnerable. Current management practices – harvesting jack pine before they are at risk – greatly reduce jack pine budworm impacts.

In 2022, the first significant outbreak of jack pine budworm since 2015 was recorded. Roughly 28,000 acres of jack pine was defoliated, compared to 118,000 acres in 2015.

Most of the damage was in the central and eastern Lower Peninsula, but a few small areas were also mapped across the eastern Upper Peninsula. Continued damage is expected for 2023.



Top right: Dots on a map indicate jack pine budworm infestation areas, primarily in Michigan's northeast Lower Peninsula, with some in the eastern Upper Peninsula.

Right: Browned tops of trees and branches show the effects of a jack pine budworm infestation.

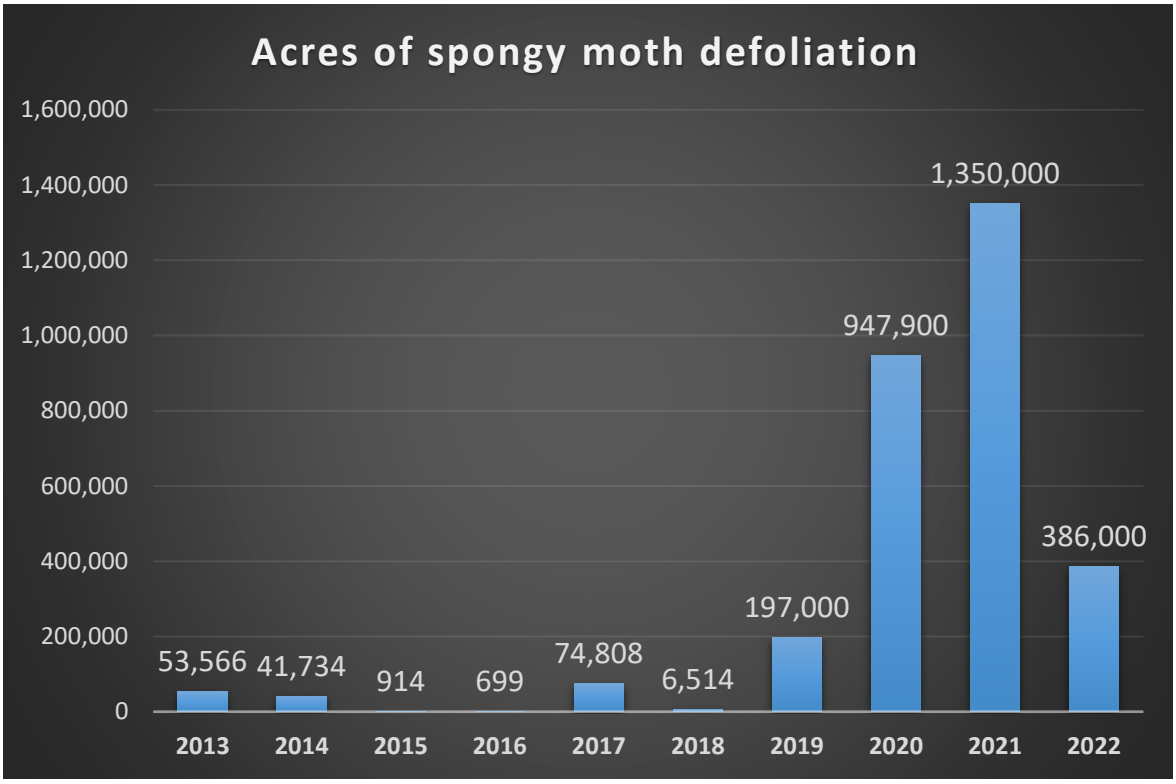
Historic spongy moth outbreak begins to ease

Lymantria dispar dispar

The light at the end of the tunnel is finally here. After four years of historic defoliation levels across the state, Michiganders are starting to see relief from the hungry spongy moth. The moth of many names was formerly known as the gypsy moth or by its Latin name, *Lymantria dispar dispar*.

Populations of spongy moth collapsed across much of the northern Lower Peninsula in 2022 following record levels of defoliation. Mapped at 1.35 million acres during 2021 aerial surveys, levels dropped to fewer than 386,000 acres in 2022. Annual forest health aerial surveys typically monitor over 22 million acres annually, tracking the buildup and collapse of various insect and disease outbreaks.

Spongy moth was first detected in Michigan in 1954 and was present throughout lower Michigan and parts of the Upper Peninsula by the 1980s. Today, spongy moth populations have been naturalized across Michigan, behaving more like a native pest, limiting their impact. Outbreaks typically occur every seven to 10 years. Severe defoliation rarely occurs more than two to three years in a row at any location. Once populations collapse, caterpillar numbers remain low, and defoliation is unnoticeable for several years.



Before 2019, the last notable outbreak was recorded in 2009-2010, when defoliation peaked at roughly half a million acres. Like the current outbreak, 2009 population increases coincided with drought, unusual precipitation patterns and frost damage in mature oak stands, which caused tree stress. During the early part of outbreaks, natural biological controls including predators, parasitoids, and diseases such as *Entomophaga maimaiga* and the NPV virus struggle to keep up with building moth populations. As populations peak, the material caterpillars feed on becomes limiting, and biological control catches up. This results in outbreak collapse without human intervention. Healthy deciduous forests can withstand a few years of defoliation with limited long-term impacts.

Tiny parasitoids attack a brown spongy moth egg mass.

Defoliation can still be a nuisance to homeowners living in or near outbreaks. There are many ways to help reduce the impacts of infestation. To help high-value yard trees survive, deep watering during extended dry spells can save stressed trees during outbreaks. A light fertilizer application in late fall can also help trees rebound from stress caused by defoliation.

Egg mass surveys can provide a good idea about what to expect next year. If you see abundant egg masses on a few trees, you may have a sizable outbreak next spring. However, if you only see a few, the outbreak may have already collapsed in that area.

Visit Michigan State University's spongy moth webpage for techniques to help control an infestation around your home. These techniques can help make conditions more tolerable during outbreaks, but they will not remove outbreaks completely. These techniques are meant to help reduce the nuisance around your home, while the predators, parasitoids, virus and fungi take hold and collapse the outbreak.

Male spongy moth.

Female spongy moth laying eggs.

Spongy moth caterpillar stage.

Further information:

- Michigan State University's spongy moth webpage.
- NotMiSpecies Webinar on spongy moth – a presentation by federal, state and university experts.
- At-home control techniques – YouTube video by North Country Cooperative Invasive Species Management Area.

Diseases

Armillaria root rot colonizing trees

Armillaria spp.

Michigan became famous 30 years ago for its "humongous fungus": an Armillaria fungus near Crystal Falls thought to be 2,500 years old, spread over 185 acres and weighing 400 tons.

The fungus that created the stir was discovered by university researchers.

The fruiting stage of Armillaria fungus is the honey mushroom. Midwest American Mycological Information.

Although impressive, Armillaria can cause damage by rotting tree roots. Armillaria root rot is common in many areas of the United States and throughout Michigan. However, several different species of Armillaria fungi occur. Each species attacks different hosts to different degrees. Many tree species, as well as shrubs, vines and horticultural crops, can be infected by Armillaria.

Armillaria root rot is often observed on dead or dying trees and is commonly detected during forest health surveys. It is associated with pockets of dead red pine and declining oak but can also be found on trees dying for other reasons such as oak wilt, Heterobasidion root disease or other issues. MHow large a role Armillaria infection plays in the death of a tree depends on a variety of factors that can be responsible for a tree's decline.

The fungus is frequently present in diseased or decaying plant material and roots, causing no apparent damage to healthy trees. The fungus produces root-like structures called rhizomorphs that allow it to spread, although roots of healthy trees may become infected when they grow near diseased roots and other materials. Spores produced by honey-colored mushrooms could also initiate infection.

White mycelial tissue from armillaria rot on a red pine.

Depending on the species of Armillaria and the host, healthy trees can be attacked, but the disease most commonly is associated with trees already stressed or dying due to factors such as drought stress, advanced tree age, defoliation and other disease and insect issues.

Management primarily involves maintaining tree health and vigor. Good stand management is key for preventing or suppressing Armillaria infections in woodlots. To reduce the potential for infection, water high-value ornamental landscape plantings during dry spells, avoid soil compaction and avoid wounding trees.

Symptoms of Diplodia blight include browned or dead branch tips.

Diplodia tip blight hit Lower Peninsula pines

Diplodia sapinea

Diplodia shoot blight, caused by the *Diplodia sapinea* fungus, is prevalent in many areas of Michigan, although symptoms may not always be obvious. Infected trees may have no symptoms until they're stressed by drought or wounded by hailstorms or other events.

In Michigan's natural and planted forests, Diplodia is primarily a concern for red and jack pine, although a range of other pine and conifer species are also hosts. The disease is a concern for Christmas tree plantations and ornamental landscape plantings as well.

In 2022, the Michigan DNR's forest health team received reports of Diplodia damage associated with young red pine in areas of the Lower Peninsula experiencing drought.

Infected trees produce Diplodia spores on blighted twigs and cones. In forest settings, spores rain down from taller overstory trees and infect seedlings and trees in the understory below.

Branches and cones left behind from harvests of infected pines may also harbor spores that infect newly planted seedlings. Hail damage or drought can cause shoot blight and stem cankers on larger trees, killing those shoots and branches. Moisture stress on newly planted seedlings from an overly damp environment can lead to stem collar rot, which in turn can kill the seedlings.

Due to the prevalence of Diplodia and the appearance of symptoms after drought and hailstorms, uneven-aged management of red pine (for example, selection thinning where some groups of trees are selected for harvest and others are left behind) may be a risky option.

Stands without evidence of Diplodia in the overstory can be considered for uneven-aged management. However, Diplodia may rapidly become apparent after tree-stress events. These stands should be monitored and overstory removed as soon as regeneration goals have been attained.

Spruce decline caused conifer thinning, dieback

Multi-issue complex

Spruce decline is caused by a variety of factors, resulting in thin foliage. Image from Steve Katovich, USDA Forest Service.

Although spruce budworm defoliation has been an issue in areas of the state, many spruce trees across Michigan looked thin in 2022 for other reasons. Slowly progressing canopy thinning, needle drop and dieback are symptoms of spruce decline, a complex of issues that overwhelm a tree's defenses.

Some lower branch death may be due to canker diseases or infections associated with the inner bark. These cankers may eventually girdle the limb, causing needle drop and dieback. On a dying branch, when stripping the outer bark, you may see an area of discolored tissue where the infection occurred. In the Lower Peninsula, research at Michigan State University in the past decade has identified Diaporthe (Phomopsis) as the most common fungal canker associated with these symptoms on Colorado blue spruce. Norway spruce and our native white spruce were also susceptible in the studies.

Needle loss associated with lower and interior branches is also often associated with Rhizosphaera and Stigmina needle cast diseases. While these diseases can also account for branch death, it is also common to see branches with green needles only at the branch tips.

Several environmental factors may be involved in spruce decline. Colorado blue spruce and Norway spruce are not native to Michigan. Some native spruce may not be growing on ideal sites. Trees may also be stressed by recent fluctuations in climate. In some locations, decline symptoms vary greatly between trees. This may be from microclimate variation, individual tree genetics or other variables.

Good general tree care practices, including appropriate stand management and watering high-value trees in the landscape during dry periods, will reduce tree stress, improving tree health. Pruning affected lower branches off large spruce trees may increase airflow and eliminate a source of fungal spores. In large plantings, thinning or removal of competing vegetation may increase airflow and sunlight reaching trees, reducing infection potential. However, spruce is considered shallow-rooted, and there are concerns that thinning plantations may stress trees through soil compaction. This could allow bark beetle infestations to develop or result in wind throw. Severely affected trees are unlikely to recover and should be removed, chipped or burned to reduce bark beetle pressure on remaining healthy trees.

In an ornamental setting, fungicides can protect highly susceptible Colorado blue spruce when applied before severe needle cast infection occurs. Native spruce trees tend to have some resistance to the needle cast diseases and may be a better planting option. However, in some situations favorable for infection, significant needle cast infection has also been noted on native white spruce.

Oak decline condition repeating 1970s oak struggles

Multi-issue complex

In 2022, oak decline reports came in across the northern Lower Peninsula, an increase from elevated oak decline issues observed for the last decade or so.

Michigan's oak forests are subject to periodic episodes of oak decline, which become more significant as much of the oak resource ages. This is not a new phenomenon. Nearly 45 years ago, the 1978 Michigan forest health pest conditions report described extensive oak decline in several counties in the northern Lower Peninsula. Historically, oak decline has been most common in the northern Lower Peninsula, but it can occur statewide anywhere oak is present. It is most frequently associated with northern pin oaks, northern red oaks and, occasionally, black oaks.

Oak decline occurs when several factors work together to kill trees. Many of our oak forests were generated after widespread logging in the early 1900s, contain trees of a similar advanced age and are growing on poor sites characterized by dry, nutrient-poor, sandy soils. These factors set the trees up for decline. In recent years, these forests have also been periodically defoliated by insects such as spongy moth and subjected to drought and late-spring frosts that younger, more vigorous trees can take in stride.

Native insects, including wood-boring beetles like two-lined chestnut borer, are attracted to and able to attack stressed, low-vigor oak trees. Native diseases such as Armillaria root rot also can successfully colonize these weakened trees. These insects and diseases are often blamed for tree death, despite the other factors involved.

Oak decline can appear patchy and random across the landscape.

It's important to keep in mind that Michigan's oak forests continue to age. As climate fluctuations increase, we can anticipate oak decline will continue, even in the absence of spongy moth defoliation. DNR forestry staff works to identify stands at risk and, when possible, harvest declining trees. This helps regenerate a younger, more vigorous and resilient forest comprised of oak and other tree species better suited to local site conditions.

Oak decline is often confused with oak wilt, a more aggressive but less common cause of oak mortality. Although oak decline can appear to happen quickly, individual trees die from oak decline more slowly than from oak wilt. Oak decline often appears widespread on the landscape, while oak wilt usually starts as a single dead tree. It then expands to small pockets of dead trees that increase in size over several years.

Invasive plants

Invasive shrubs threaten to overtake forest floors

While much of forest health work is rightly focused on trees, shrubs also are an important part of the forest. These compact, woody plants help curb soil erosion, enrich soil with leaf litter and provide food and shelter for wildlife. Plants and especially shrubs labeled invasive, which are non-native species that cause harm, can wreak havoc in a forest environmentally and economically.

Invasive honeysuckles can be found and controlled in fall, when they keep their leaves longer than other trees and shrubs.

Some invasive shrubs, including several species of honeysuckle (Amur, European fly, Morrow's and Tatarian), grab space better than many native plants by having a different time cycle: The invasives naturally put out their leaves earlier in spring and keep them later in fall, meaning more energy for invasives and more competition for natives.

Japanese barberry is common in gardens.

Other species, like Japanese barberry, change the pH of nearby soil, making it difficult for native plants to grow. This shade-tolerant understory of invasive shrubs can impact forest regeneration because tree seedlings have a harder time establishing. This means it takes more years to fill a gap in the forest from a tree falling, a catastrophic wind event or logging activity. This reduces the productivity of a woodland and hurts a forest manager's bottom line.

Impacts aren't limited to other plants. The fruits of many invasive shrubs aren't as nutritious to birds and mammals as the natives they replace, yet these animals spread seeds from the parent plant. The thicket-forming multiflora rose can make it impossible for larger mammals to move through the area it's growing in. Direct harm happens too: Common and glossy buckthorns put chemicals into soil and water that harm frogs and salamanders.

Multiflora rose, from Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Different parts of our diverse state have different priority species; in particular, the U.P. has fewer invasives and more native look-alikes. Working with your local cooperative invasive species management area is a great way to get the scoop about what's going on in your region. No matter where you are in the state, prevention is a crucial step to protect our forests.

All the invasive shrubs mentioned in this article arrived in Michigan because we planted them in our gardens. Using native or noninvasive alternatives can make a big difference. Practice PlayCleanGo when you walk, camp, use an off-road vehicle or otherwise recreate outside. It's another important, simple step to prevent the spread of invasive species.

Left: Using a boot brush before and after hiking can limit the spread of invasive plant seeds that can be trapped in boot treads.

Below: Japanese barberry is a common landscape plant. However, birds spread the seeds into the forest, where the shrub can dominate the understory. Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Additional resources:

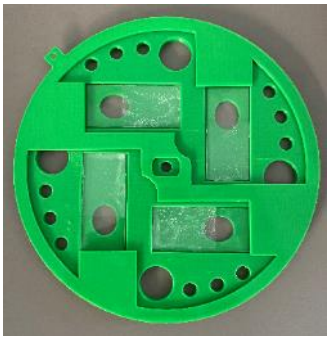
- Find your regional cooperative invasive species management area: Michigan.gov/invasives/take-action/local-resources.
- Midwest Invasive Plant Network Control Database: MipnControlDatabase.wisc.edu.
- Alternatives to woody invasives (Woody Invasives of the Great Lakes Collaborative): WoodyInvasives.org.

Research and monitoring

Grand Valley State University – Partridge Lab

Tracking eDNA to detect hemlock woolly adelgid and other forest health issues

Charlyn Partridge



3D-printed eDNA trap.

DNA is everywhere. When anyone touches the surface of a table, takes a drink from a cup or scratches the surface of their skin, DNA traces are left.

Dr. Charlyn Partridge's lab at Grand Valley State University's Annis Water Resources Institute takes advantage of that environmental DNA, known as eDNA, to help track the presence of invasive species. Her lab is using airborne eDNA to look for hemlock woolly adelgid in Michigan.

HWA is a tiny, invasive insect present in five west Michigan counties. It attaches itself to hemlock branches and sucks sap. HWA lay eggs in cottony, white ovisacs and move from tree to tree during their crawler stage. Over time, these insects can weaken or kill hemlock trees.

Through a 2018 USDA Forest Service grant, airborne eDNA traps were designed and tested to capture HWA crawlers and associated material such as ovisacs. Over the next few years, the traps were tested and modified to improve their efficiency and ease of use. The airborne eDNA traps consist of a 3D-printed base and lid. Microscope slides coated with petroleum jelly on one side serve as the capture surface. Anything that becomes stuck in the jelly is then processed in the lab through DNA extractions, and samples are checked for the presence of adelgid DNA.

Deployed eDNA trap in the Huron-Manistee National Forest.

In 2022, the lab deployed 100 traps in hemlocks along Lake Michigan's coast in the Lower Peninsula. First, traps were deployed in moderate- to high-risk areas where HWA has not yet been detected through surveys conducted as a means of continued early monitoring. The lab will evaluate how well visual surveys correlate with information gained from the eDNA traps to ensure the methods are equally effective.

Secondly, traps were deployed in areas with known HWA infestations that have been treated. Traps will help estimate infestation levels and evaluate the treatment over time.

Finally, the lab is exploring whether these eDNA traps can be used to monitor for other invasive species and fungal pathogens. Because the traps also collect fungal spores and plant pollen, the lab will be using an approach called metabarcoding to identify other plant and fungal species that are present in these areas. This would increase the ability to monitor for several problematic species simultaneously using airborne eDNA-based approaches.

Michigan State University – McCullough Forest Entomology Lab

Understory conditions on sites colonized by beech bark disease

Ren McIntyre, Nick Zoller and Deborah G. McCullough

We are revisiting 62 sites originally established in 2002-2003 to assess progression and impacts of beech bark disease, an invasive forest pest complex comprised of beech scale insects that facilitate infection by a non-native fungal pathogen.

Undergraduate student assistant Connor Vanwagoner measures a beech tree with a beech thicket in the background.

Beech bark disease was first detected in eastern Canada in the 1930s and has since caused mortality of much of the mature beech resource in the northeastern U.S. It was found in Michigan in 2000. To date, we have resurveyed 46 of the original 62 sites to evaluate overstory conditions, regeneration and coarse woody debris and estimate abundance of the beech scale insects and presence of trees infected or killed by the pathogen.

In 2021-2022, regeneration in the 46 sites was largely dominated by beech, hop hornbeam and sugar maple. Density of young beech trees, including recruits (1-4-inch diameter at breast height) and saplings (less than 1-inch diameter, greater than 1 meter tall) was higher, and beech represented a greater proportion of regeneration in sites where mature beech trees have been killed by beech bark disease.

New seedlings did not show a similar change, presumably reflecting the decrease in annual beech mast following mortality of mature beech trees. Dense beech recruits and saplings, called beech thickets, are becoming more common in affected sites, but are undesirable. Beech trees are rarely browsed by deer, and the dense regeneration provides negligible habitat for wildlife. Young trees, less than approximately 10 inches diameter at breast height, do not produce beech nuts. Beech thickets also suppress other tree species from establishing. We plan to resurvey the remaining long-term impact sites in 2023.

Long-term impacts of beech bark disease on forest conditions in Michigan

Nick Zoller and Deborah G. McCullough

Beech bark disease, an invasive pest complex comprised of tiny, sap-feeding beech scale insects and a fungus that kills the tree's inner bark (phloem), was first detected in Michigan in 2000, near Ludington in the Lower Peninsula and north of Newberry in the Upper Peninsula.

Beech is particularly important for many wildlife species that feed on beech nuts and use cavities in large trees as habitat. We established plots in 62 forested sites in 2002-2003 to monitor disease

progression and impacts over time. At that time, only a small portion of sites had beech scale, and there was no evidence of any beech bark disease-related mortality.

When these sites were revisited in 2012, beech scale had spread into the central Upper Peninsula and across much of northwest Lower Peninsula. Beech trees had begun to die in the U.P., but there was negligible beech mortality in lower Michigan.

We began resurveying these same 62 sites in 2021 and continued this work in 2022. Variables recorded in each site include beech scale presence and density, overstory trees by species and condition, regeneration by species, and coarse woody debris. To date, 46 of the original 62 sites have been resurveyed, including all 28 sites in the Lower Peninsula and 18 of 34 sites in the U.P.

Beech scale is present in 45 of the 46 sites assessed in 2021-2022, compared to 17 sites in 2003. The remaining uninfested stand is in Saugatuck Dunes State Park, the most southern of the original sites.

Dead beech tree with cankers caused by the Neonectria fungal pathogen.

Graduate student Nick Zoller examines beech scale insects on the trunk of a beech tree.

Across all 46 sites surveyed in 2021- 2022, 41% of beech trees are dead. In the Lower Peninsula, 18% of the total beech basal area, a measure of stand density, is dead; in the U.P., 33% is dead.

In sites that had high beech scale infestation in 2003, dead beech basal area averages roughly twice as much as in sites that had not been invaded by beech scale in 2003.

Large beech trees, which are more likely to be colonized by beech scale and become infected by the invasive pathogen, account for much of the mortality. Since 2003, average diameter at breast height (a standard measure of trees) of live beech trees has decreased by 9.9 cm. In 2023 we will survey the remaining 17 impact sites in the Upper Peninsula.

Black ash conditions at varying stages of the emerald ash borer invasion

River Mathieu, Deborah G. McCullough

Black ash, predominantly found in mesic hardwood forests in the northeastern United States and eastern Canada, is a foundational wetland and cultural keystone species. Black ash is often a dominant species or even the only tree species in forested wetlands and swamps and bogs and along water edges.

Members of many Native American and First Nation tribes harvest black ash for artistic and utilitarian basketry, and some tribes have spiritual ties to black ash. Unfortunately, this species is the most vulnerable and preferred host for the emerald ash borer in North America.

We are quantifying forest conditions in black ash stands representing different stages of emerald ash borer invasion as part of a regional assessment with collaborators in New Hampshire and New York. We also launched research in 2022 to evaluate regeneration in black ash sites in Michigan, where post-invasion, mid-invasion and pre-invasion forests are represented. Questions to be addressed include presence, age, health and density of young black ash (called recruits), response of young black ash trees to mortality of overstory trees and densities of non-ash species that may compete with black ash.

In 2022, we evaluated black ash regeneration in 10 post-invasion sites in the Lower Peninsula and eastern Upper Peninsula, eight mid-invasion sites in the Upper Peninsula where ash borer densities are near peak and seven sites in the western Upper Peninsula with little or no emerald ash borer evidence.

Technician Tim Harrison walks through a post-invasion black ash stand.

In post-invasion sites, characterized by complete or nearly complete death of black ash trees in the overstory, black ash recruits (trees 1-4 inches in diameter at breast height, a standard tree measurement commonly referred to as DBH) were present in all 10 sites, with an average density of 585 ± 56.3 recruits per hectare. Average density of black ash recruits in mid-invasion sites and pre-invasion sites averaged 430 ± 204.6 and 776 ± 264.3 recruits per hectare, respectively. We observed ash borer galleries, characteristic tunnels made by the borers under tree bark, on black ash as small as 3 centimeters (about an inch) DBH in some post-invasion sites.

Beginning in 2023, we will use dendrochronology, a process of dating by tree rings, to understand the temporal and spatial dynamics of black ash regeneration. Ultimately, our results should provide insight into the likelihood of black ash persistence given the ongoing spread of the ash borer.

Monitoring and managing emerging and invasive insect pests of chestnuts

Max Ferguson, Deborah G. McCullough

A weevil larvae emerges from a chestnut.

Chestnuts are a versatile specialty crop that can be eaten fresh or used to make products such as gluten-free flour or beer. Although most chestnuts consumed in the United States are imported from Europe and Asia, Michigan is the leading producer in North America. Chestnuts also are planted to provide hard mast, or food, for many types of wildlife. Unfortunately, expanding chestnut acreage brings increased pressure from native and exotic insect pests.

Larvae of the lesser chestnut weevil (*Curculio sayi*), a native insect, are especially destructive in commercial orchards. These small, creamy-white grubs develop inside nuts before chewing through the shell. Larvae spend one to three years in soil before pupating and emerging as adults. Adult weevils are difficult to trap, making it a challenge to scout for them or monitor the population. The extent of a weevil infestation may not be known until larvae emerge from chestnuts on store shelves or consumer countertops.

In 2021 we evaluated the attraction of adult weevils to selected volatile compounds emitted by chestnut flowers and burrs. Results led to the development of a lure, which we tested at an MSU research orchard in 2022. Preliminary results suggest this lure may be attractive to female weevils, which could help improve population monitoring. We also performed extensive trials of post-harvest treatments, which involve submerging infested nuts in hot water to identify the optimal conditions to kill weevil larvae without affecting nut quality.

A chestnut tree branch is covered in bumpy galls.

We continued to monitor distribution and spread of the invasive Asian chestnut gall wasp (*Drycosmus kuriphilus*), which was first detected in Michigan in Berrien County in 2015. High gall densities can reduce both tree vigor and yield. Sticky traps, which capture dispersing adults, and visual surveys for galls led to the detection of eight newly infested sites in 2022. Since 2016, the wasp has spread 18 to 39 miles per year and is now present in 13 counties across southwestern Michigan.

It can be spread long distances by moving nursery stock or cuttings from trees. Spatial and temporal dynamics of the wasp within individual orchards were also assessed. A species-specific parasitoid (*Torymus sinensis*), first detected in Berrien County in 2017, has been found in all infested orchards one to three years after the wasp arrives. Parasitism rates by this biocontrol agent range from 20 to 70% of larvae.

Post-treatment assessment of hemlock trees following insecticide treatment to control hemlock woolly adelgid

Timothy R. Harrison, Justin Keyzer, James Wieferich, Sasha Lepeschkin-Noel and Deborah G. McCullough

Efforts continue in the western Lower Peninsula to contain and control infestation by hemlock woolly adelgid following the detection of this invasive forest pest in the state in 2015.

Connor Vanwagoner and Justin Keyzer grind hemlock needles for residue analysis using a commercial blender.

In the eastern United States, systemic insecticides have long been used to protect trees and entire watersheds from tree deaths due to HWA. Eastern states rely primarily on soil-drench applications of imidacloprid for HWA control. In Michigan, however, imidacloprid is primarily applied via trunk injection, while imidacloprid or dinotefuran can be applied via trunk sprays.

From 2016-2019, we conducted studies involving 140 hemlocks in two different sites. Goals included evaluating the efficacy of treating trees with imidacloprid, dinotefuran or a mix of both products applied via trunk injection or basal trunk sprays. We also monitored HWA density and tree condition. Early results showed dinotefuran moved more rapidly through trees and controlled HWA within a few months, while imidacloprid required several months to affect HWA. Levels of imidacloprid remained high enough to kill most HWA for at least three to four years. Dinotefuran persisted for about two years.

We are continuing to work with these 140 trees to monitor HWA levels or reinfestation, tree condition and growth, and imidacloprid persistence. In fall 2022, shoots were collected from hemlock trees involved in these studies. Shoots will be dried until needles separate from twigs, then needles and twigs will be ground to a fine powder. Processed samples of foliage and twigs will be analyzed with two different methods to quantify concentration of the imidacloprid and secondary compounds, some of which are also toxic to HWA.

We are also cooperating with USDA Animal and Plant Health Inspection Service and Forest Service colleagues to quantify effects of HWA on secondary growth of the trees over time.

Native longhorned beetle communities of Michigan

Paige Payter, Deborah G. McCullough

A cross-vane panel trap set near the ground and a second trap in the lower canopy of a tree at a research site.

While the potential establishment of non-native woodborers is a concern, identifying native woodboring communities is also of interest to forest and forest insect ecologists.

Acquiring information about the distribution and relative abundance of native longhorned beetles in the family *Cerambycidae* is another focus of research at Michigan State University. Native longhorned beetles play important roles in nutrient cycling and maintaining productive forests.

Two cross-vane panel traps have been deployed in at least 14 sites annually since 2017. Sites include urban industrial areas such as manufacturing plants as well as recreational areas such as popular campgrounds. At each site, one trap is hung 5-7 feet high from a rebar section embedded in the ground. The other trap is hung from a branch in the canopy of a tree, where some beetle species may spend most of their life span. Both traps are baited with a lure that is broadly attractive to numerous species of longhorned beetles, along with ethanol.

From 2017 to 2021, we captured more than 9,000 individual beetles representing 97 different native species of longhorned beetles. This included 28 species that were collected in all years and 27 species that were collected only in one year.

Abundant species captured in traps included *Xylotrechus colonus*, the rustic borer, and *Neoclytus mucronatus*, a medium-sized beetle with brown and yellow markings. Both species are thought to be able to develop in a broad array of hardwood trees. As this research continues, we plan to assess how land use, overstory tree cover, trap height and the type of tree the trap is deployed on affect the communities of native longhorned species.

Student research assistant Drew Lacommare checks traps to collect captured beetles.

Post-treatment assessment of hemlock trees following insecticide treatment to control hemlock woolly adelgid

Alexandra Lepeschkin-Noel and Deborah McCullough

We conducted a study in 2022 to evaluate a novel method for detecting hemlock woolly adelgid presence, monitoring phenology (periodic biological phenomena that are correlated with climatic conditions) and assessing abundance among infested sites by trapping crawlers.

Justin Keyzer sets up a sticky stake trap.

First-stage "crawlers" that hatch from eggs are the only mobile life stage of HWA. The elongate, pink-colored crawlers can move from one tree to an adjacent tree on overlapping branches or can be blown off infested trees and carried for some distance by wind. They also can be spread by contact with humans, animals or objects that are close to trees such as campers or trailers. Once crawlers settle and begin feeding, they remain attached to the tree for the rest of their life span.

We established two to three plots in four sites in west Michigan where at least a portion of the hemlock trees have been treated with systemic insecticide to control HWA. Sticky traps, comprised of coated cardstock covered with a sticky compound known as Pestick, were hung on branches or attatched to stakes at varying distances from hemlock trees. We set traps in early May and replaced them approximately every two weeks from May to early July, encompassing the period when crawlers are active. Traps were bagged individually, then placed under a microscope to count the crawlers. We also recorded the size and health of and HWA presence in all the hemlocks included in our plots. Two sites had low to moderate HWA densities, while the other two sites had relatively high HWA levels.

Tim Harrison counts HWA crawlers on a trap.

Crawlers were captured on traps in all sites and plots, but fewer crawlers were captured by traps in sites with a lower number of infested trees than in the sites where nearly all hemlocks were infested with HWA. Crawlers were captured even on stake traps that were 20 meters from any hemlock tree, indicating that wind can carry crawlers at least that far.

We also captured crawlers on hanging traps even in sites where we could not see any HWA on trees in the plots during our field assesments. These results indicate that this method can be used to effectively monitor HWA presence in newly infested or reinfested sites, identify crawler activity and compare relative HWA abundance among sites, which may be missed by visual assesments alone, and to monitor abundance of HWA in the years following insecticide treatment.

Michigan State University – Sakalidis Forest Pathology Lab

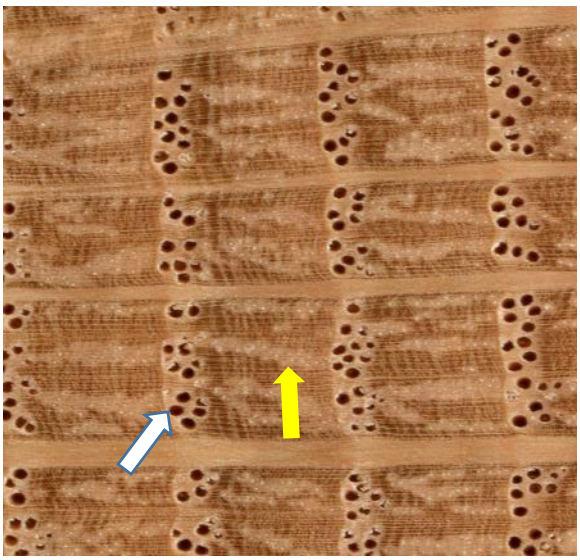
Sakalidis Lab research updates

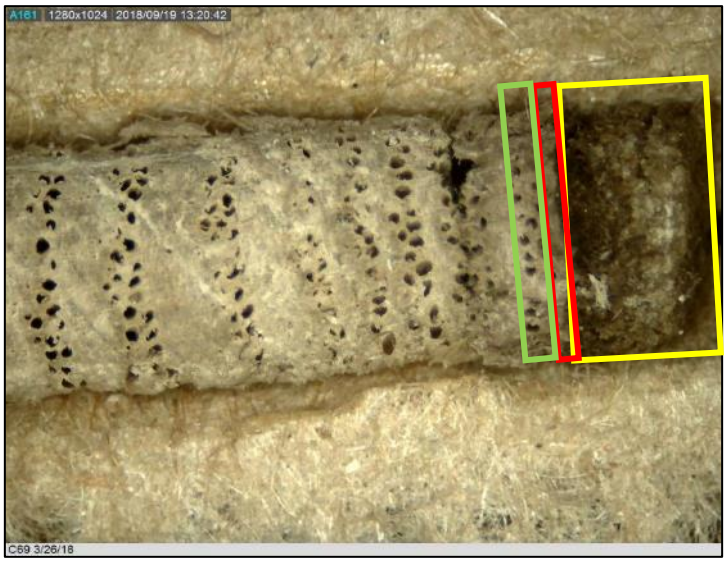
Monique L. Sakalidis, Karandeep Chahal and Pablo P. Parra

The Sakalidis lab uses molecular ecology and plant pathology approaches to understand the causes, distribution, spread and impact of tree pathogens, or disease-causing organisms. These approaches can help mitigate and respond to tree diseases and improve tree health with a focus on emerging native pathogens, and exotic invasive pathogens. The lab is currently focusing on oak wilt, white pine diseases, beech leaf disease and chestnut diseases.

We found that trees inoculated during earlywood production (May-July) exhibited faster oak wilt progression than trees inoculated when xylem was comprised of latewood (March-April, August-September). This also corresponded to reduced sap flow, as estimated by transpiration. In periods with no or low sap flow, such as October and November, inoculated trees were no longer susceptible to infection.

Our results support our hypothesis that earlywood vessels transport a higher magnitude of sap comparative to latewood vessels, which most likely facilitates faster movement of *Bretziella fagacearum* within red oak. Xylem sap flow appears to be a main determinant of oak wilt susceptibility and disease progression. The transition to latewood during the growing season may not determine susceptibility to





Annual growth rings of Quercus rubra.

Left panel: Large-diameter earlywood vessels are indicated by a white arrow, whereas much smaller latewood vessels are indicated by yellow arrow. Image by the Wood Database.

Right panel: An increment core sample composed of bark (yellow rectangle), latewood vessels (red rectangle), and earlywood vessels (green rectangle). Image by Olivia Morris.

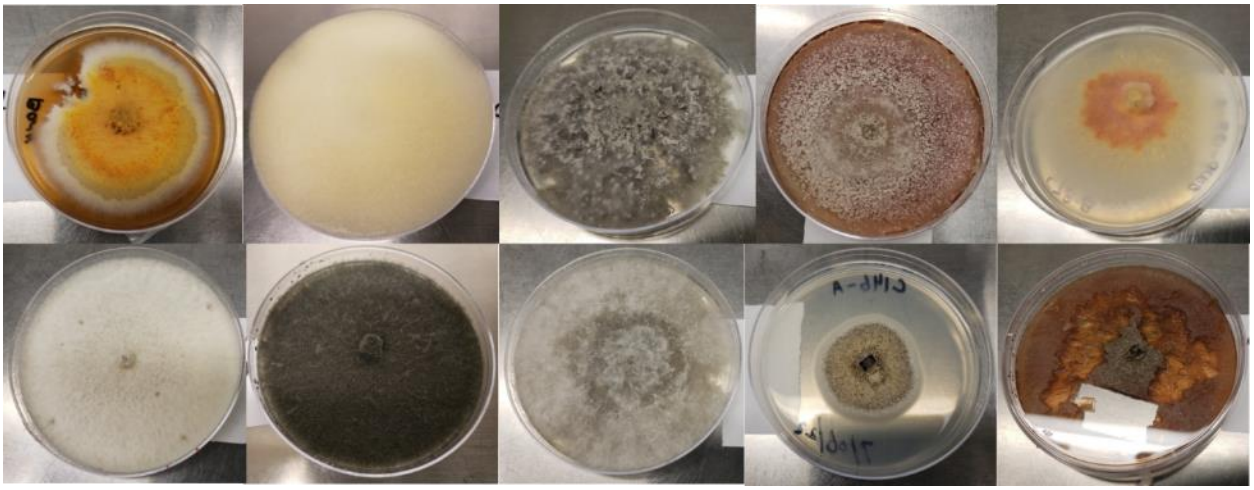
infection but does influence the rate of disease progression, as the smaller latewood vessels move sap more slowly.

Sakalidis lab members at a stump experiment site. Photo by Monique L. Sakalidis.

To evaluate whether stumps can serve as an infection court for oak wilt, freshly cut stumps were infected in the fall of 2021. All stumps were revisited in 2022, and stump sprouts and adjacent oak trees were monitored.

No oak wilt symptoms were observed, and surrounding trees and stump sprouts were all asymptomatic. *Bretziella fagacearum* has not been successfully recovered from any of the inoculated oak stumps. This experiment will be repeated in the spring of 2023.

We have collected 147 fungal isolates associated with noninoculated and inoculated oaks. We have identified 100 out of 147 fungal isolates by DNA barcoding of the ITSrDNA region. These fungi belong to 38 different genera. We are using this library of oak-associated fungi to assess the specificity of molecular protocols used for *Bretziella fagacearum* detection in diagnostic labs nationwide. We are also working with researchers in Canada and the United States to develop highly sensitive and specific molecular methods for oak wilt detection in the laboratory and the field.



Diverse fungi species grew from samples isolated from oaks. Photo by Pablo P. Giraldo.

Michigan Technological University – Bal Forest Health Lab

Lab projects: Overview and highlights

Tara L. Bal

Treating buckthorn spouts with liquid spray of experimental fungal biocontrol.

The Bal Lab at Michigan Technological University specializes in forest health monitoring and aims to provide problem-solving strategies for managing forest health issues that affect Michigan forests and forest products. This includes research programs that span issues related to insects and diseases, invasive plant species and their associated drivers.

For example, we are working with collaborators on multiple research topics associated with maple dieback, including identifying the impact of earthworms on maple sap chemistry; better understanding maple dieback risk assessment; and long-term management strategies for impacted forests.

In another example, we are collaborating with the Keweenaw Invasive Species Management Area and investigating potential use of a native fungus, *Chondrostereum purpureum*, as a mycobiological control on invasive buckthorn plants. These are primarily glossy buckthorn, *Frangula alnus*, and common buckthorn, *Rhamnus carthartica*. From our initial testing after just one field season, the fungal treatment was as effective as glyphosate, reducing stump sprouting up to 80% relative to untreated controls.

The following articles highlight additional ongoing research projects.

Beech bark disease resistance and forest plantings

Ande Myers and Tara L. Bal

American beech is an important ecological resource in Michigan that has been threatened by beech bark disease since the beech scale was first detected in 2000. It is further under threat from the much newer beech leaf disease, detected in 2022. Our current efforts with beech aim to produce more beech bark disease-resistant seed directly into forests. This could gain valuable time, as implementing effective

Grafted beech ready for fall planting outdoors.

mitigation and management solutions in mature trees for both beech bark disease and beech leaf disease will take years if not decades.

We have been collecting samples from confirmed beech bark disease-resistant American beech, in collaboration with National Park Service partners, and begun a grafting and planting program within the Pictured Rocks National Lakeshore and Sleeping Bear Dunes National Lakeshore. In underplanting trials within forests not previously documented with American beech, we are developing transplanting methods to improve survival of the containerized rootstock.

Simple trials were established for common horticultural questions about American beech, such as the best time of year to plant, amount of ground disturbance needed and whether collaring planted beech is necessary when underplanting American beech. After the first year, average growth was slightly higher in late fall plantings, with minimal site preparation (manually tilling a 1-foot radius around planted trees) and including tree collars.

This trial is ongoing, and results will be assessed after three to five years of growth. Additional trials will explore the effect of grafting stress and planting. We'll look at traditional full-sun orchard plantings versus forest understory conditions in relation to survival, growth and seed set of grafted beech.

These results will inform future plantings of our grafted beech bark disease-resistant beech within the national parks. In promoting the genetics of proven resistant trees for at least BBD, we aim to improve the long-term prospects for beech in Michigan.

Oak wilt – potential vector behaviors in northern Michigan forests

Tara L. Bal and Sharon Reed – Ontario Ministry of Natural Resources and Forestry

Oak wilt is found throughout the Lower Peninsula but in just three counties in the Upper Peninsula, each bordering Wisconsin. Despite susceptible host trees, native vectors and local wood movement, the disease has not been detected across most of the Upper Peninsula, nor has the disease been confirmed in Canada.

In 2021 and 2022, we began a collaborative, parallel project to evaluate timing and relationships between hosts (oak trees), vectors (nitidulid beetles) and environmental variables to better understand risk of oak wilt expansion north. We monitored weather variables, collected nitidulids from flight traps baited with pheromone or bread dough and artificially wounded oak trees to monitor wound visitation by nitidulids across four sites in the Upper Peninsula (including a stand with oak wilt in Iron County).

Using the same protocols, partners conducted a similar study across 10 sites in eastern Canada, including five sites near Sault Ste Marie, Ontario.

In 2022, more than 2,000 nitidulid specimens were collected in Michigan alone. It is extremely time-consuming to identify them by separate species. Thankfully, we have entomology taxonomist partners with the Invasive Species Centre in Ontario, Canada, to assist with species verifications.

Across all Upper Peninsula and Ontario sites so far, we have identified three nitidulid species that were only found in the artificial wounds, and seven species only collected in flight traps. Another 11 species were collected in both.

A major finding so far has been that wound visitation of nitidulids and flight peaks appear asynchronous.

Lab technician Michael Arkwright reinstalling a bark plug after checking for nitidulids.

Nitidulids were collected in traps far earlier in the spring than they were found in wounds, and they are collected longer throughout the summer from wounds after flight collections taper off. These finding have implications that could result in refining the overland spread risk and no-pruning guidelines for the U.P.

Eight different nitidulid species were identified from a single flight trap collection.

Data analysis and collaboration continue to answer additional research questions related to nitidulids outside the current range of oak wilt. Collectively, our results will provide valuable insight into the potential movement of oak wilt farther north across a wide geographic range, especially in the light of climate change affecting timing and behavior of vectors responsible for overland spread.

Taking action for thriving forests

Tips to manage timber for a healthy forest

A forest is always changing. Often when trees die, the cause is a combination of several stressors. These can be environmental factors, advanced age, pests, pathogens or invasive plants. Knowing the history of an area, species composition and age of trees growing there can help when determining the best management actions to meet objectives for a healthy forest.

Harvesting trees is an option that can help ensure the long-term health and vigor of your timber stand. It is important to know when and how to responsibly harvest to ensure the most healthy, productive and vigorous stand. It's also important to know what, if any, pests and pathogens are occurring or pose a potential threat. This knowledge will help determine the type and timing of management that should or should not take place. As forested areas age, trees begin to lose vigor and become more vulnerable to pests and disease. All tree species have different life spans, soil requirements and light preferences.

Trees in a thinned forest after a timber sale have more access to resources like light, nutrients and water to grow.

For instance, aspen and paper birch have relatively short lifespans, whereas northern white cedar and hemlock can live much longer. Although harvesting trees while they are still suitable for market is the goal of many landowners and foresters, having some standing dead or dying trees adds value to the forest. They offer habitat for cavity-dwelling wildlife species, later serve as ground cover for small mammals and amphibians, and finally become a nutrient source for living trees.

Insects and pathogens are often more attracted to specific species or age classes of trees. When you have diversity either with tree species or age classes, the stand is often less likely to be wiped out by a forest health threat. Age and species diversity can also help limit or reduce the spread of a threat by disrupting the lifecycle. Through timber management, you can help promote minority species in a stand and encourage new age classes and increase diversity.

In addition to managing forests by tree age, certain types of stands are managed by tree density. Thinning reduces tree density by harvesting when competition for available resources (light, nutrients, moisture) becomes limiting for tree growth and health. This type of management provides a diverse age class, which can help with the health of a stand by allowing younger trees to reach the canopy and fill the gaps left by older, less vigorous trees. It’s important to note that, when thinning a stand, you should select the trees with poor form and deformities as the trees to remove. This ensures you are keeping the healthiest trees for future seed production.

When carrying out any timber sale, best management practices will help ensure the health of the forest and avoid damage. An important practice when setting up a timber sale is knowing how water flows through the area. It's imperative not to impede the natural flow of water, which can cause standing water that can drown trees. By using appropriate culverts and bridges when building roads and skid trails to haul logs out of the stand, you can limit disruptions to the natural water flow. It's also important to time harvests when soils are not excessively wet. Different soil types have different water-holding capacities and should be managed depending on weather conditions.

Rutting and soil compaction can devastate a stand. Heavy equipment causes rutting, which can change the hydrology, damage the root systems and lead to the death of the trees retained on site. It also can cause tree regeneration issues. The use of slash, or tree branches piled on the ground along skid trails, can help keep rutting from occurring. Slash piled on skid trails to avoid rutting should be removed from wet areas when skidding is complete to ensure that water can flow naturally.

Any type of logging activity will lead to some residual damage to trees left standing. Residual damage reduces the value of the timber and can open wounds for insects and pathogens. An experienced logger can help manage how the finished timber sale looks and improve long-term health of the stand. When a forester marks trees for harvest, it should open the stand up enough for a logger to fell trees and operate equipment. Finally, it is most important to establish a well-written contract to ensure both that the final product is healthy and that all parties involved are satisfied with the outcome.

Additional resources:

Forest management projects	• Consulting foresters – MichiganACF.org. • Conservation district foresters – Michigan.gov/MiFAP. • Foresters who write management plans – Michigan.gov/ForestStewardship. • Foresters who administer timber sales – Michigan.gov/RegisteredForester. • Michigan Master Loggers – mimlc.com. • Loggers and sawmills – MichiganTimbermen.com.
Forest health issues	• DNR Forest Health – Michigan.gov/ForestHealth. • MDARD Forest Health – Michigan.gov/ExoticPests. • MSU Extension Forestry – canr.msu.edu/forestry. • MSU Plant and Pest Diagnostic Lab – canr.msu.edu/pestid. • Invasive Species – misin.msu.edu. • Financial Assistance – nrcs.usda.gov/conservation-basics/conservation-by-state/michigan. • Michigan Invasive Species Watchlist – Michigan.gov/invasives/id-report/watchlist.

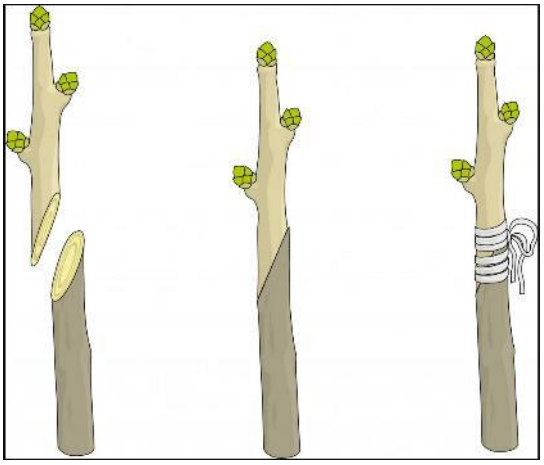
Tree breeding techniques could help restore lost trees

Michigan's forests have experienced devastating effects due to invasive species in recent decades. Chestnut blight, Dutch elm disease, beech bark disease and emerald ash borer are invasives that have dramatically changed our forests.

In some areas, tree species have mostly disappeared from the landscape, removing the ecological, social and economic benefits they once provided.

Grafted trees are grown in a greenhouse and tested against pests or diseases to determine resistance. Image from Melanie Moore, USDA Forest Service.

As new invasive species, a changing climate, fragmentation and other pressures challenge forests, species diversity becomes increasingly important for a healthy forest. Bringing back populations of lost or threatened tree species would have many benefits.



Tree grafting diagram: A branch clipping is fused to a different branch and root system. Image by S. Murkulov.

Tree breeding is a long-term effort that often begins with identifying potentially resistant host trees in forests where a pest or disease has already caused mass decline and mortality. It may take decades to discover surviving or potentially resistant trees on the landscape. Once trees are identified, branch clippings can be grown to root directly or be grafted (fused) to a young root system to start a clone, or copy, of the parent tree. Once these clones are established, they can be tested to determine the level of resistance to a pest or disease. Partially resistant clones can be crossed to produce offspring with greater levels of resistance. These offspring can then be used to establish seed orchards that, in time, will produce resistant seeds to bring back tree species that have been nearly wiped out.

USDA Forest Service scientists and others, with assistance from partners in Michigan and elsewhere, have been evaluating techniques and beginning breeding projects for several affected Michigan species, including beech, ash and elm. Today, we have made great progress in identifying partially resistant or resistant clones and have begun to plant seed orchards to eventually help restore forests.

With green ash, researchers have been able to find partially resistant parent trees and have recently installed a large seed orchard in Michigan. This seed orchard will still need a decade to grow before trees are able to produce partially resistant seed. As exposure to emerald ash borer in other areas of the

state continues, additional ash will be identified and incorporated into breeding work. Seed orchards of beech bark disease-resistant beech have also been planted, although technical challenges remain in producing resistant seeds that are free of other diseases.

Elm clones are also being evaluated. In winter 2021, branches were collected from large surviving elm trees reported by citizens in northern Michigan. These were propagated by the USDA Forest Service and will be tested with Dutch elm disease to identify tolerance or resistance levels.

Other challenges remain. Selecting specific clones reduces genetic diversity, and trees resistant to the pest or disease of concern may be vulnerable to other existing problems. New invasive pests and diseases may also impact these trees in the future. More information on how to ensure resistant trees planted on the landscape will survive and grow is also needed. By continuing to look for and propagate additional surviving trees that may resist pests and diseases, we can ensure greater genetic diversity in seed orchards and eventually restore lost trees like magnificent chestnuts and graceful elms.

For more information on Great Lakes tree-breeding efforts, visit the Great Lakes Basin Forest Health Collaborative.

Branches are harvested from a disease-resistant tree that survived the Dutch elm disease to be used for propagating new seed-producing trees.

Michigan Invasive Species Coalition fosters collaboration

Michigan is one of many states embracing a collaborative approach to invasive species through cooperative invasive species management areas, called CISMAs. Michigan's CISMAs, funded by the USDA Forest Service in 2006, were originally established as cooperative weed-management areas. The program was modeled after successful partnerships in western states focusing on invasive species prevention, detection and control by local groups, complimenting federal efforts. Considering that invasive plants and insects don't observe property lines, land managers must work together for success.

Michigan achieved CISMA representation in every county in 2017 and now has 22 groups. The success of these partnerships between local and state agencies is notable. Today, the Michigan Invasive Species Coalition, consisting of CISMAs and their supporting partners, coordinates the efforts of groups working to control invasive species. The MISC facilitates cooperation across CISMAs and tracks progress on emerging issues, fulfilling Michigan's invasive species management priorities.
Goals include:

- Provide a network for local and regional invasive species coordinators.
- Share information among those working to control invasive species.
- Address common challenges in implementing control efforts.
- Enhance state invasive species communication.

CISMA reps visit an invasive mile-a-minute weed site.

The MISC Core Team was formed to bridge communication gaps between CISMAs and partners. CISMA regional representatives are chosen by the CISMA coordinators to meet and communicate about issues they face. CISMA regional representatives bring their region's voice to quarterly MISC Core Team meetings, where it can be added to discussions about invasive species management. Supporting partners are associated with academic institutions, nonprofit organizations and government agencies. Since the team's founding, communication has improved, leading to programs addressing invasive species in more sophisticated ways.

Another benefit of the MISC network is the ability for CISMAs to meet, gain new skills and share resources at events like the MISC Summer Field Trip. CISMA coordinators have expertise in managing target species, but sometimes need field experience to recognize native species of interest, monitor native species diversity and use field data in an adaptive management framework. This year's field trip focused on these topics to improve cohesive management. CISMA coordinators visited sites and learned about mile-a-minute weed, kudzu, red-swamp crayfish, beech leaf disease and spotted lanternfly.

MISC also organizes an annual meeting. This year's meeting will include updates from CISMAs, The Nature Conservancy and government agencies. An organizational psychologist will highlight ways to manage staff and field crews. Other topics will include new approaches to invasive species control, tribal partnerships and a skill session focused on geographic information systems, permitting and budgeting.

Michigan's CISMAs and their supporting partners play a crucial role in invasive species management. The Michigan Invasive Species Coalition helps them work better together, making their work more effective.

Spot a suspected invasive species? Report it!

Michigan sometimes seems like a dumping ground for new plant, insect and disease species from around the world that have the potential to devastate the state's trees and forests.

While new species have been arriving since European settlement began, transportation has evolved from a typically harsh, months-long voyage across a large ocean to an overnight flight around the world. This makes it easier for undetected pests to hitch a ride to a new continent or halfway around the world. These invasive species have been known to cripple native ecosystems, diminish productivity in forests or decimate rows of street trees in urban and suburban neighborhoods. The good news is that in some cases, we can use knowledge from outside the state or country to understand and prepare for threats that may put Michigan at risk in years to come.

To help prevent establishment of these pests, Michigan developed a watchlist of species of concern. The watchlist raises awareness of species that have a strong potential to arrive, establish and spread in the state. For species such as the Asian longhorned beetle, beech leaf disease, hemlock woolly adelgid and spotted lanternfly, the watchlist helps inform residents of the risks and gives them the tools to prevent, identify and report these forest health concerns.

But the work doesn't stop there. In addition to helping spread the word, response and communication strategies are developed to help Michigan prepare for potential introductions. Species-specific plans help identify critical steps needed to respond to a new detection. This year, public awareness and well-planned response strategies have helped to slow the spread of hemlock woolly adelgid in west Michigan as well as new detections of spotted lanternfly in Oakland County and beech leaf disease in St. Clair, Oakland and Wayne counties.

Without observant and knowledgeable residents willing to help detect and report these pests, forest health concerns go unnoticed for long periods, making it much more difficult to address them after detection. It is critical, if you suspect you have observed a potentially damaging invasive species, to take photos, record the location of the infestation and if it's an insect, bag it and freeze it. Then report it.

If you believe you've found an invasive species, please use one of the available reporting options:

Midwest Invasive Species Information Network

- Report sightings through the MISIN website or submit through the mobile application.

Michigan Department of Agriculture and Rural Development

- Email MDA-Info@Michigan.gov or call the MDARD Customer Service Center at 800-292-3939.

Michigan DNR Forest Health Team

- Email suspected sightings, with photos, to DNR-FRD-Forest-Health@Michigan.gov.
- View and report oak wilt locations using our interactive oak wilt map.
- View and report Heterobasidion root disease locations using our interactive HRD map.

Contact and acknowledgements

Contact

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Acknowledgements

This report was developed and published with the support of the United States Department of Agriculture Forest Service. Information and articles for this publication were provided by:

- The Grand Valley State University Partridge Lab.
- The Michigan Department of Agriculture and Rural Development.
- The Michigan Department of Natural Resources.
- The Michigan State University McCullough Lab.
- The Michigan State University Sakalidis Lab.
- The Michigan Technological University Bal Lab.

Many thanks are due to the article writers and agencies for their time and contributions.

Cover photo by Michigan State Parks Ambassador Danielle Grandholm at Warren Woods State Park.

Nondiscrimination statement