Michigan 2023
Forest Health Highlights

Michigan Department of Natural Resources
Forest Resources Division

Introduction

Forests provide a long list of benefits. They clean our air and water, prevent soil erosion along rivers, streams and dunes, support timber production and the economy, provide recreation and wildlife habitat, store carbon, shade our homes, cool our streets, and boost our mental and physical health.

Addressing forest health plays a vital role in deriving these benefits for all living things, including humans, who depend on forests. When the health of the forest declines, the capacity of the forest to deliver those benefits also declines.

One of the biggest challenges to maintaining healthy forests is addressing pests and diseases. Forests have evolved with native insects and diseases, adapting to maintain forest benefits during historically predictable outbreaks. Climate change is altering these outbreaks and creating new challenges for forest managers. Climate change creates uncertainty about the extent, timing and severity of outbreaks. This unpredictability increases with every new invasive insect, disease or plant introduced into our forests. The longer invasives are at play, the harder it is to reverse the negative impacts they have on forests and the people and wildlife who depend on them.

Forests are a natural climate solution because they sequester carbon and keep it out of the atmosphere. Insects and diseases threaten this capacity to store carbon. A recent study found that areas affected by insects reduced carbon sequestration by an average of 69% compared to areas unaffected by insects. Forests with diseases sequestered 28% less carbon. More than 40% of the nation's forest biomass is at risk of invasion by established pests. Forest health programs that prevent and manage these pests are critical to addressing climate change.

Forests provide economic benefits to rural and urban communities and supply renewable products that we need, including homes, furniture and paper products. Economies can suffer greatly when forest health issues arise. It is estimated that invasive insects alone cost the U.S. over $2 billion per year and an additional $1.5 billion in lost property value. These economic impacts are not equally distributed across landowners. State and federal governments bear the costs from impacts to public lands, while landowners and local municipalities face costs when invasives are introduced to cities and communities.

Forest health programs are geared to protect our forests and the benefits we receive from them. While many of our challenges are serious and at times the outcomes are devastating, there are tools and strategies we can employ to change that outcome. Where we can prevent new introductions, detect new pests early and respond strategically, we invest in our forests for current and future generations.

Yours in cooperation,

Sue Tangora
Forest Health and Cooperative Programs Manager, Michigan DNR, Forest Resources Division

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Balsam woolly adelgid tufts.

A tiny attacker is making its move on Michigan's fir trees. The balsam woolly adelgid is a sap-sucking insect introduced to North America on infested nursery stock from Europe. Balsam woolly adelgid was first observed in the northeastern United States and southeastern Canada around 1900. The adelgid feeds on true fir trees including balsam fir, Fraser fir and white fir. Repeated attacks can weaken trees, cause twig gouting, kill branches, and eventually cause trees to die. Symptoms of an infestation may include:

- Tiny, white woolly tufts on the lower trunk of the tree.
- Swelling and distortion of twigs, called "gouting."
- Flagging: A branch or branches that turn red and die.
- Tree tops that become narrow, misshapen and sparse.

Lifecycle

In its native range, the balsam woolly adelgid alternates between spruce and fir tree hosts. However, in North America, it remains on fir, as there is no European spruce. Adelgid populations in North America are all females that reproduce without mating in a process called parthenogenesis. This is because sexual reproduction requires the European spruce.

An immature nymph stage is the only stage that can survive winter. The overwintering nymphs are black and tent-shaped, with a row of short, white, waxy filaments running down the middle and around the edge of their bodies. The nymphs start to mature in March or April, getting plumper and producing the namesake woolly covering of wax to protect themselves from predators. The purple-black adult is completely hidden from view by this covering.

Adults lay honey-colored, oblong eggs in a clutch. In the laboratory, females can produce as many as 200 eggs, but they produce far fewer in nature, possibly due to climate or the host tree's health. Eggs hatch within a month to produce the next stage in the lifecycle, the crawler. The crawler looks like the egg, only with eyes and legs. The crawler must quickly find a suitable site to feed, or it will die. Once it chooses a site, it never moves again. It molts through nymph and adult stages, then lays eggs, all while attached to the tree by a feeding tube it uses to extract sap.

Balsam woolly adelgid detected in Michigan

Balsam woolly adelgid poses a threat to the roughly 1.9 billion balsam fir trees within their native range in Michigan's northern Lower and Upper peninsulas. Fraser fir and white fir are not native to Michigan but are common landscape trees. Firs are important to Michigan's Christmas tree industry. Producing nearly 13.5 million trees each year, Michigan is the country's third largest Christmas tree grower.

Balsam woolly adelgid was not detected in Michigan until August 2021, when officials at the Michigan Department of Agriculture and Rural Development were notified of several infested Fraser firs in Kent County. A robust response effort followed, focusing on public outreach, surveys and removal of infested firs. Investigators determined that the trees were planted a decade ago, but unfortunately were not able to determine their origin. Surveys detected more than 100 ornamental firs of varying species within a one-mile radius of the infestation, but no balsam fir, as Kent County is considerably south of its native range. Potential host trees were inspected for signs of infestation, with locations recorded for future monitoring. No evidence of additional infestation was detected within the survey area. The eight infested Frasier fir were cut and chipped in the winter of 2021. Follow up surveys in late 2022 found no evidence of balsam woolly adelgid in Kent County.

Surveyors mark trees with balsam woolly adelgid.

Preventing further spread

No new detections of the balsam woolly adelgid occurred until late 2023 when it was found in two locations: Missaukee County in the northern Lower Peninsula, and further south along Lake Michigan in Oceana County. These new infestations have created unique challenges. Missaukee County is well within balsam fir's native range, with many native firs in the vicinity of a pocket of infested trees. Though Oceana County is south of the balsam fir's native range, it is home to many Christmas tree farms, predominantly featuring various fir species. In both cases, infestations are located on private property. It is likely in both cases that the adelgid was introduced via infested planting stock.

During surveys, the location of host trees, presence of balsam woolly adelgid and progress are recorded using ARCGIS Field Maps. Survey efforts in Oceana County have identified the boundaries of a small infestation. Infested trees will be destroyed in early 2024. Surveys for the Missaukee County infestation are planned, with destruction of infested trees in early 2024.

Michigan has maintained a balsam woolly adelgid exterior quarantine since 2014 to limit the introduction of adelgids from sources outside the state. All species within the genus Abies are restricted from entry unless the stock is produced in an area where the adelgid is not known to occur or produced under an active pest management program. Exemptions are provided for holiday greenery, Christmas trees, debarked lumber and heat-treated material. Michigan is the only state to maintain a quarantine.

Early detection and response are key to preventing the spread of invasive pests. The Michigan Invasive Species Program has increased public outreach and direct messaging to nursery growers, Christmas tree producers and landscapers across the state to help detect additional infestations before further spread.

Partners investigate spotted lanternfly infestations

Lycorma delicatula

An invasive spotted lanternfly. Image from the Michigan Deparment of Agriculture and Rural Development.

Spotted lanternfly continues to be a major concern in the United States. Since its discovery in 2014 in southeast Pennsylvania, the lanternfly has spread in the northeast, mid-Atlantic and Midwest. In total, 14 states including Michigan are currently responding to infestations. The insect can spread rapidly and local spread is common. Long-distance spread is often due to hitch-hiking along rail lines, shipping routes, or private and commercial transportation. Unintentional movement occurs at every life stage, but egg masses have the highest likelihood of moving to establish the pest in new areas.

Identification

Spotted lanternfly identification depends on the season. During the winter, only egg masses are present. When they are first laid in the fall, egg masses look like fresh putty or wet clay. As they age, they crack and begin to look like dried out, gray mud or mortar. Each egg mass can contain 30-50 eggs. Nymphs hatch from egg masses in the spring and pass through four life stages before molting into adults. During the first three life stages, the insects have small black bodies with white spots. During the fourth stage, they gain red patterns in addition to the white spots. Finally in fall, the fourth nymph stage molts into an adult. Adults are approximately one inch long with spotted wings featuring red, black and gray.

Host plants and risk

Spotted lanternfly feeds on at least 70 species of trees and woody vines. However, the list is much shorter for preferred hosts such as tree of heaven and native trees that can be used by the spotted lanternfly to complete its full life cycle. So far, observations suggest natural forests aren't significantly affected by spotted lanternfly. The potential impact to Michigan's specialty fruit crops such as grapes is a concern. Although damage to vineyards has been reported in other states, research and outreach conducted by government agencies and universities has provided growers with tools deal with this pest.

During feeding, the insect ingests large amounts of sap via a piercing, sucking mouthparts, resulting in a loss of nutrients from the host plant. During feeding, the insect excretes sugar water known as honeydew. Honeydew supports the growth of black sooty mold that fouls the surface of leaves, preventing photosynthesis, and attracts secondary pests such as flies and yellow jackets.

Distribution

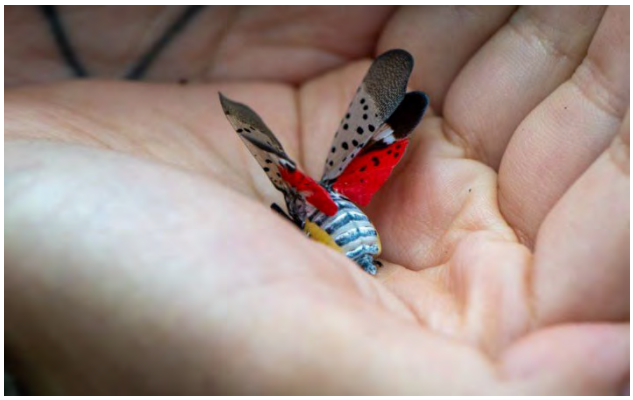
In August 2022, state officials were notified of a spotted lanternfly infestation in Pontiac on a single, 15-acre parcel of land owned by Oakland County. Investigators were able to determine that the infestation came to Michigan via egg masses laid on East Coast nursery stock. Investigations helped to track all potentially infested stock moved from the nursery. Resulting inspections found no evidence of spread, suggesting the eggs hatched before nursery stock was moved. Each site will be monitored.

Response

Surveys and traps used in 2022 and 2023 have not detected expansion of the infestation in Oakland County. Working with county officials and U.S. Department of Agriculture Animal Plant Health Inspection Services, MDARD implemented a trap tree strategy consisting of removing small-diameter tree of heaven and geolocating remaining tree of heaven. Remaining trees were treated with an insecticide, dinotefuran, after they flowered to kill spotted lanternfly feeding on them. Plastic catch basins have been installed at the base of trap trees to monitor the effectiveness of insecticide treatment. In addition to insecticide treatments, more than 470 egg masses were removed from the site in February 2023. Circle traps placed within the area provide a rough measure of population changes.

Compliance agreements with nurseries were implemented to allow continued sale and transport of stock, and include training, inspection, treatment and recordkeeping requirements.

The infestation site is in a commercial area that provides multiple pathways for spread. To limit this potential, cooperators have contacted businesses in the immediate area. Residents and landowners within a mile radius received letters sharing the situation, identification tips and instructions to report sightings to state officials.



Closeup of a spotted lanternfly preparing to take flight.

Outreach efforts such as press releases and public presentations informed people to watch for spotted lanternfly and provide state and partner agencies with reports of suspected sightings. Reports are submitted to the state via the Eyes in the Field application, which collects observations and provides a method to investigate and respond. Great Lakes Restoration Initiative grant funding was used to place billboards in strategic locations. Detections of individual insects in southeast Michigan have been confirmed, but no additional populations have been reported.

Monitoring efforts by agencies across the state are aimed at detecting spotted lanternfly before isolated populations grow beyond a manageable size. State grants fund Cooperative Invasive Species Management Areas to place circle traps at high-risk transportation hubs and stopovers in portions of southwest Michigan. In addition, CISMA staff surveyed rail lines in response to spotted lanternfly detections along rail lines in Indiana. State and federal surveys were also conducted in high-risk areas. Survey efforts have not detected established populations. Active infestations are moving closer to Michigan borders, however, and more infestations are expected to become established in the state.

The hemlock woolly adelgid battle is Michigan's biggest statewide forest health effort

Adelges tsugae

Why is a tiny fluff so dangerous to hemlock trees?

A closeup of an infested branch shows the namesake "wool" produced by hemlock woolly adelgids.

Hemlock woolly adelgid is a tiny forest insect that feeds on the sap of hemlock trees. If left untreated, this pest can kill a tree in four to 10 years. The adelgid feeds at the base of hemlock needles and is identifiable by its cottony white ovisacs.

Controlling this pest is important because Michigan is home to 176 million hemlock trees that play a key role in the landscape. Hemlocks, especially in dense stands, stabilize sand dunes, offer wildlife food and habitat and play a significant role in keeping cold-water trout streams cold.

The adelgid, often referred to as HWA, was first detected in Virginia in 1951. Since then, it has spread and killed millions of eastern and Carolina hemlocks. In Michigan, hemlock woolly adelgid was first detected in 2006. Since then, infestations have been confirmed in seven counties: Allegan, Benzie, Mason, Muskegon, Oceana, Ottawa and Washtenaw. Spread has been attributed to factors ranging from wind to birds, animals and even unknowing outdoor enthusiasts or travelers. Roughly 8 million people annually visit state parks with known HWA infestations. This is a concern not only because of the potential for spread, but also because local economies can be affected if the adelgid harms trees in those areas.

Densities of hemlock woolly adelgid vary along the Lake Michigan shoreline, from single trees to infestations covering thousands of trees. Forest health staff focus on containing HWA, as infestations are surrounded by three natural barriers: Lake Michigan to the west and sparse to no hemlocks to the south and the east. This puts the focus for surveys and treatments on the northern infestation.

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. Current populations in Michigan were introduced through infested nursery stock planted before the quarantine or in violation of the quarantine. In 2017, an internal quarantine was implemented. It was revised in 2020 and 2023 to restrict hemlock plant material movement out of and within the infested areas.

The Michigan HWA Coordinating Committee's statewide strategy focuses on high-priority areas such as prevention, detection, management, outreach and research. This strategy was written in 2017 and updated in 2021.

Collaboration among researchers and staff has been vital to address Michigan's unique situation. The coordinating committee continues to pull from new information gathered within and outside the state by agencies, professionals and researchers. Researchers and managers from northeastern states and Canadian provinces convene annually to summarize and discuss new or improved tools to help mitigate the pest. This year, the ninth annual Hemlock Woolly Adelgid Program Managers' Meeting was held in Blacksburg, Virginia. These meetings help Michigan forest health staff collect and share information that has significantly improved understanding of the invasive pest.

Hemlock woolly adelgid collaborators

Federal: U.S. Department of Agriculture 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 in 2023 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, Michigan Technological University and University of Michigan.

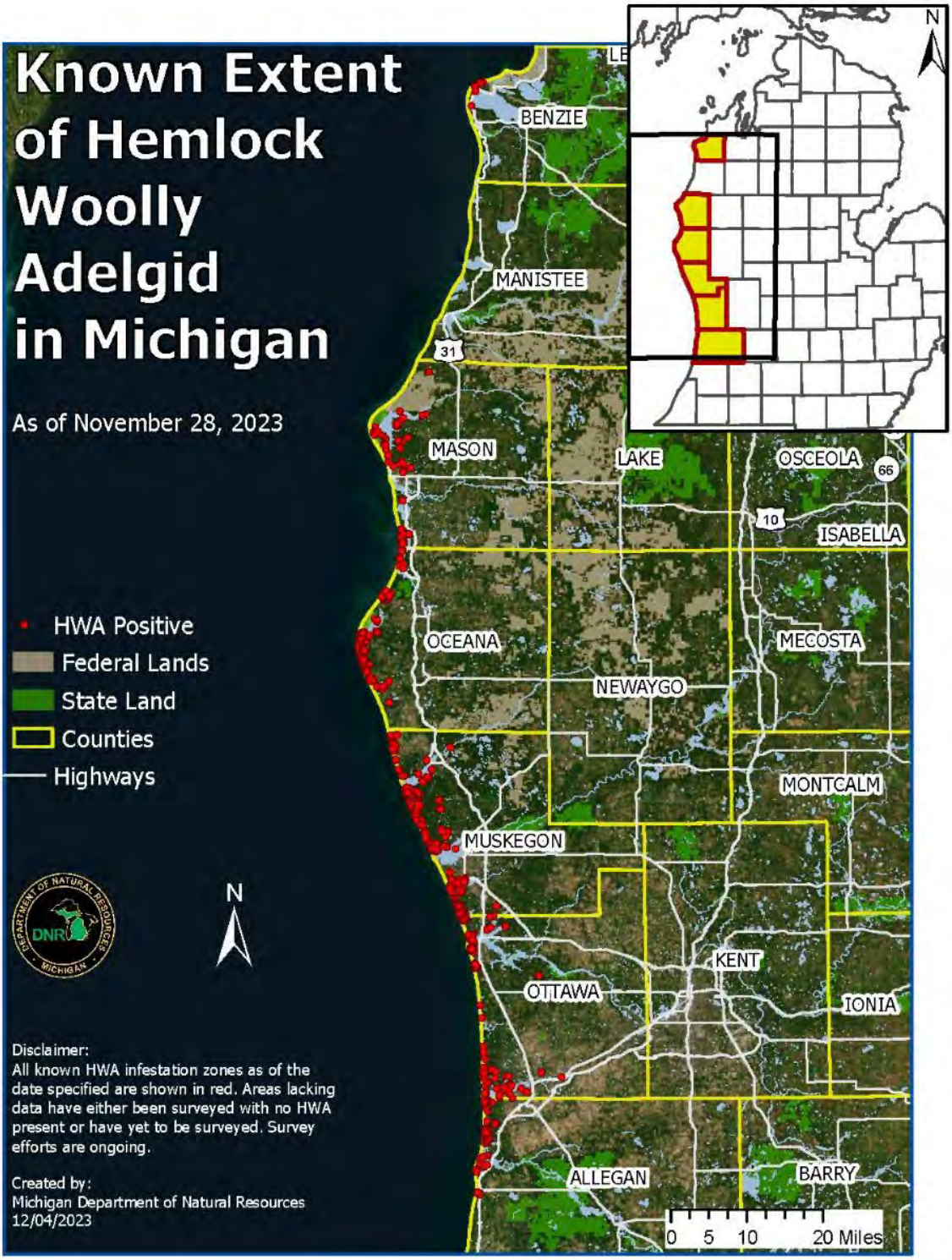
Hemlock woolly adelgid survey efforts

Surveys for hemlock woolly adelgid began in Michigan in 2016 after established infestations were found in two counties along Lake Michigan and continue to be a priority to this day. The HWA Statewide Strategy, Protecting Michigan's Hemlock Resource by Responding to Hemlock Woolly Adelgid, lists surveying as a key action to ensure we fully understand distribution of the insect to properly prioritize response.

High-risk areas along the Lake Michigan coastline in both the Upper and Lower peninsulas are being surveyed by state and partner agencies.

Intensive survey efforts can help forest health programs plan and respond to early HWA infestations.

Hemlock woolly adelgid map



In January, staff from the Northwest Michigan Invasive Species Network detected hemlock wooly adelgid on private land while conducting routine survey efforts in Benzie County. This site is just south of Sleeping Bear Dunes National Lakeshore and is now the most northern known infestation in Michigan. Adelgids were detected on several trees at the time of survey, leading to a new county being added to the infested county list for the state. Together, staff from the NMISN, Mason-Lake Conservation District, and Michigan DNR worked together to complete more detailed surveys of this site in preparation for treatment. Surveys will continue in this area by DNR staff and partner agencies.

An additional infestation was found in May in Washtenaw County. This infestation was in an arboretum, outside Michigan's naturally occurring hemlock range. Additional outreach was conducted in the area to equip private landowners with best management practices if they suspected hemlock woolly adelgid on their planted hemlock. This site was determined to be lower risk due to its distance from naturally occurring hemlocks and limited hosts. DNR and MDARD staff will continue to work with local partners to address this site.

The Forest Health Response Team for the DNR's Forest Resources Division continued to focus survey efforts on state and federal lands. This includes surveying for new infestations and to prepare for treatment. In 2023, the team worked with staff from the Forest Service on treatment surveys on the first infestation found within the 800-foot buffer of the Manistee National Forest.

The DNR's Parks and Recreation Division leads hemlock woolly adelgid response efforts on state park lands. The division has established a year-round forest health corps to focus on surveys and treatment. Surveys ranged from Berrien County north to Leelanau County and east into Wexford and Grand Traverse counties.

Lastly, private and local public land has been covered by many partners, but primarily by Cooperative Invasive Species Management Area crews. Partnerships with these local organizations are critical to adequately address hemlock woolly adelgid on private land.

Survey acres by partner: Winter 2022-2023

Agency	Detection survey acres	Counties surveyed
Sleeping Bear Dunes and Pictured Rocks National Lakeshores	682	3
Michigan DNR Forest Resources Division	127	1
Michigan DNR Parks and Recreation Division	5,815	12
Local Cooperative Invasive Species Management Area organizations	12,355	9
Agency totals	**18,979**	**25**

Hemlock woolly adelgid treatment efforts

Containment of hemlock woolly adelgid is a top priority in Michigan with insecticide treatments being the primary tool. Treatments of the infested areas in the northern front and outlier populations are being prioritized with the goal of slowing down and containing the adelgid's spread. DNR staff and partners work closely together to review survey data and develop collaborative, strategic treatment plans to address hemlock woolly adelgid across all ownerships.

Treatments took place on state, federal, and private lands this year with a total of 12,468 acres and 231,429 trees treated. The table below has a breakdown of the inches, acres, and trees treated by each group as well as a summary of all work completed since 2017 when treatments began.

Treatment data by partner

Agency	2023 hemlocks	2023 inches	2023 acres	Total hemlocks	Total inches	Total acres
Sleeping Bear Dunes National Lakeshore	0	0	0	64	591	3
Michigan DNR Forest Resources Division	2,381	19,135	127	5,669	57,314	1,037
Michigan DNR Parks and Recreation Division	10,324	71,919	145	57,855	388,699	2,496
Local conservation districts	49,428	395,663	2,876	167,841	1,162,108	8,932
Agency totals	62,133	486,717	3,148	231,429	1,608,712	12,468

Summary

Michigan hemlock resources continue to be at risk from hemlock woolly adelgid even after 12,468 acres and 231,429 trees have been treated over the last seven years. However, most of Michigan's hemlock trees are many miles away from established HWA populations. In addition, recent studies looking at the insect's cold hardiness suggest hemlock woolly adelgid may not currently thrive in some areas of Michigan. Further studies on climate change impacts may shed more light on this topic, with potential for an increase in areas with suitable climate in the future. Funding from the Michigan Invasive Species Grant Program, Great Lake Restoration Initiative, U.S. Environmental Protection Agency, Recreation Passport (state park user fees), fundraising efforts supported by Bob Ross International and other internal state funds continue to support these response efforts. Over the last seven years, over $6.5 million has been raised to respond to hemlock woolly adelgid in Michigan.

Landowners: Report suspected cases

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.

HRD detection efforts help protect pines

Heterobasidion irregulare

Heterobasidion root disease is one of the most economically and environmentally destructive diseases in North American forests. If ignored, the disease, commonly referred to as HRD, could limit the ability to grow planted red pine in the future and drive losses in current stands. Addressing this threat is a priority for the DNR Forest Health Program. Knowing where this disease is helps forest managers implement practices to protect nearby areas from infection.

Infections occur when fungal spores land on freshly cut stumps. After the spores germinate, the fungus slowly grows through roots that connect to nearby trees. Heterobasidion root disease spreads 3 to 6 feet per year through these root connections and will slowly kill pockets of trees. Once infected, the disease persists as long as stumps, roots or woody material remain. Over time, the impact becomes significant when thinning operations with no stump protection occur near existing infections.

On state-managed lands, an “advisory zone” of 5 miles around known Heterobasidion root disease sites is considered at increased risk for infection. When planted pine are scheduled for harvest, a survey takes place to determine the risk for infection. If risk is determined to be high, restrictions are placed on the sale. These sale specifications include winter logging from Jan. 1 to March 31, when spore production is suppressed, or specify stump treatment to prevent new infections.

Restrictions for national forest lands are slightly different from state land restrictions, but also protect from infection. Treatment should also be considered on private lands in high-risk locations. It’s important to note that winter harvest or stump treatment will not prevent existing pockets of infection from spreading.

Below: An aerial image shows expanding pockets of HRD infection.

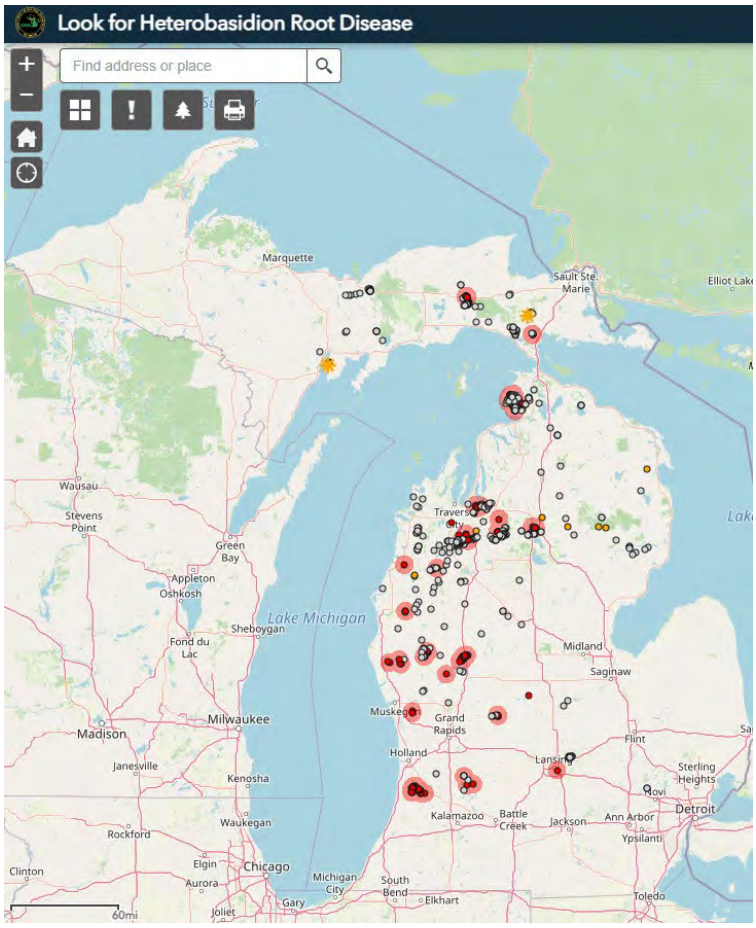
Many detections occur when pockets of dead pine are reported by DNR field staff, private foresters or the public. Landowners and managers are encouraged to watch for slowly expanding pockets of dead pines. Heterobasidion root disease is most easily identified in the fall when the fruiting bodies, or 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 unlike the gills of other common fungi.

In 2023, there were no new county detections in Michigan, although the disease was found at a few additional locations in previously positive counties. Ongoing survey activities have confirmed Heterobasidion root disease in 16 Lower Peninsula counties and two eastern Upper Peninsula counties.

An interactive, online map shows confirmed locations of the fungus in Michigan and the 5-mile advisory zone as well as locations where surveys did not detect Heterobasidion root disease.

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 link marked "View and report Heterobasidion root disease locations". Reporting potential infection areas helps protect forests for future generations.



An interactive map shows survey results for Heterobasidion root disease and allows users to pin potential new areas for DNR Forest Health Program follow-up.

Oak wilt disease strategies updated in 2023

Bretziella fagacearum

Oak wilt is an aggressive non-native, invasive fungal disease that affects all species of oaks in Michigan. It has had a significant impact on Michigan's oak resource. While it is not clear when oak wilt was introduced, the disease was first identified in 1944 in Wisconsin, and had been confirmed in several southern Michigan locations by the early 1950s. As of 2023, the disease has been confirmed in 60 counties including the majority of the Lower Peninsula and Iron, Menominee, and Dickinson counties in the Upper Peninsula.

Oak wilt is often confused with oak decline, which is currently killing more trees in Michigan's Lower Peninsula than oak wilt. Oak decline often appears widespread on the landscape, while oak wilt usually starts as a single dead tree, then expands slowly to kill adjacent trees over the years until no root grafted oaks are left alive.

Red oak species are especially vulnerable to oak wilt and may die within weeks of developing symptoms. Most trees become infected when the fungus spreads 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. The disease spreads longer distances when sap-feeding beetles carry fungal spores from dead trees to wounds on healthy trees.

Above: Oak wilt disease caused devestation in a stand of vulnerable red oaks.

Despite the loss of thousands of oak trees in forests, woodlots and residential landscapes each year, efforts to manage the disease has helped maintain a large oak resource in Michigan. In 2023, a focus of the DNR's Forest Health program was developing new guidelines to address oak wilt on lands managed by the DNR's Forest Resources Division. Different management options depend on site specific factors. When oak wilt is detected in new locations far from existing infections, eradication is a priority. Cutting roots between potentially infected trees and adjacent healthy trees with a vibratory plow is effective to prevent further spread. Other treatment options may be more sustainable when oak wilt infections are extensive across the landscape.

This may include increasing tree species diversity in a stand so fewer oak trees have connected root systems, preventing underground spread from tree to tree. In some limited situations, converting stands to other tree species may make sense.

Preventing oak wilt infection is always a high priority. Awareness campaigns are focused on how to prevent infection and avoid long-distance spread of the disease. These efforts highlight the high-risk period for infection through oak wounds from April 15 to July 15 each year to reduce local infection. Raising awareness of disease spread through transporting infested wood limits long-distance spread of the disease.

The DNR Forest Health Program has been conducting trials of an herbicide-based technique in oak wilt management that may reduce costs and increase the number of oak wilt epicenters we can treat annually. It can be used where trenching is not possible and has shown promise when used by professionals in Michigan and other states.

Oak wilt disease is easily transmitted through wounds such as storm-broken branches or intentional pruning.

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 after treatment. Consequently, limited trial treatments are being monitored at a few sites to determine how well it works under conditions in Michigan forests. We do not currently recommend the technique for widespread use until more data becomes available.

See the interactive online oak wilt map created by the DNR 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.

Surveys and observations

Significant 2023 pest activity

The following tables share data for a series of frequently reported pests and diseases causing major and minor forest health impacts in 2023. These are not comprehensive lists of all reported pests.

Name	Hosts	Status	Impacts	Signs/symptoms	Management
Armillaria root rot	Multiple species	Common statewide	Tree death in stressed trees	White fungus under bark, black “strings”; causes poor vigor, dieback, death	Promote tree health
Dwarf mistletoe	Primarily black spruce	Black spruce range	Tree death	Yellow/orange mistletoe shoots; causes decline, "witches broom” growths	Eliminate infected trees
Eastern larch beetle	Tamarack	Limited activity	Tree death	Small holes with resin oozing, reddish boring dust	Sanitation, promote stand health
Larch casebearer	Tamarack	Limited activity	Tamarack decline	Bleached/hollowed tree needles, camouflaged larvae cases	Promote tree health
Redheaded pine sawfly	Primarily jack and red pine	Low activity	Seedling and sapling death	Groups of larvae on branch tips causing defoliation	Minimize plantation edges, competition
Spruce budworm	Fir and spruce	Decreasing activity, cyclical	Tree death	Webbing, caterpillars on buds and shoots, defoliated branch tips/trees	Harvest older trees
Spruce needle cast	Spruce species	Common statewide	Spruce decline	Sparse needles, lower branch death	Promote air movement around trees
White pine weevil	Pines, spruces	Common statewide	Poor tree form	Puncture marks from weevil feeding causing crooked, wilting leaders and oozing resin	Pruning, dense or understory plantings

Minor 2023 pest activity

Name	Hosts	Status	Impacts	Signs/symptoms	Management
Anthracnose	Multiple species	Common statewide	Aesthetic	Fungus causes dark blotchy lesions and leaf drop	Promote tree health
Cherry scallop moth	Wild cherry species	Low activity	Tree stress	Defoliation and nests of brown leaves tied together can cause declines in health	Promote tree health
Fall webworm	Multiple species	Common statewide	Tree stress	Silk nests at the ends of branches, loss of leaves	No treatment necessary
Jumping oak gall	White oak	Southern Michigan	Tree stress	Leaf browning, lumpy galls on leaves, leaf curl	No treatment necessary
Lecanium scale	Multiple species	Limited activity statewide	Tree stress	Scale on twigs, sticky drops on understory foliage, thin tree canopies	Promote tree health
Maple tar spot	Maple species	Common statewide	Aesthetic	Raised black “tarlike” spots or lesions on leaves	No treatment necessary
Oak skeletonizer	Oak species	Low activity, statewide, cyclical	Aesthetic	Silk cocoons and visible larvae causing brown leaves with holes or surface damage	No treatment necessary
Ugly nest caterpillar	Cherry species	Low activity	Aesthetic	Caterpillars build silk nests full of larvae, causing loss of leaves in trees	No treatment necessary

Who's chomping the leaves? 2023 defoliator roundup

Michigan's forest environments are full of diversity, ranging from upland hardwood forests to cool cedar swamps to sun-drenched oak savannas. Even with such diversity, Michigan's 19.3 million acres of forestland have one thing in common: hungry insects want to eat the leaves from trees.

Some insects cause more tree stress than others, especially when outbreaks occur or if they become active earlier in the growing season. During aerial surveys of more than 19 million acres of land from late June to early August, Michigan DNR Forest Health experts mapped damage from multiple defoliators. These include hardwood defoliators such as spongy moth (formerly called gypsy moth), forest tent caterpillar and large aspen tortrix. Each can defoliate large areas under the right conditions. A few additional hardwood defoliators including satin moth and birch casebearer caused significant localized damage but were not mapped during aerial surveys.

Birch casebearer

In 2023, a small area of severe paper birch defoliation occurred in Delta County in the Upper Peninsula. Birch casebearer was determined to be the cause of the damage. While we anticipate impacted trees will survive a year of defoliation, stressed birch may become vulnerable to attack by bronze birch borer and other issues. Monitoring for this pest will be conducted in 2024.

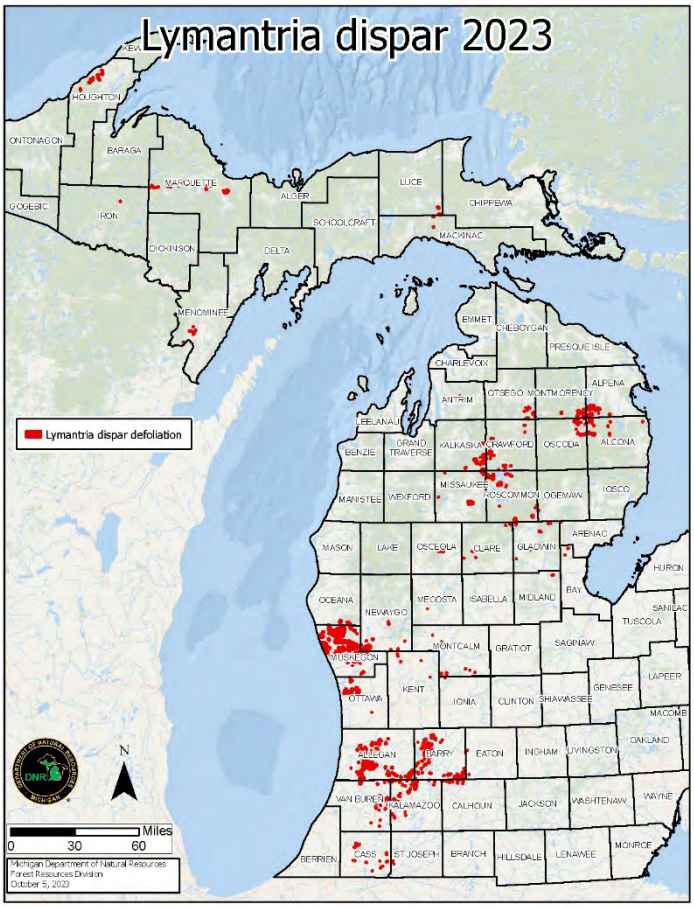
Birch casebearer damage on a paper birch leaf. Image by S. Katovich, Bugwood.org.

Birch casebearer is native to Europe and has been reported in the northeastern U.S. and Canada, causing defoliation of birch species.

While we have no previous records of defoliation in Michigan, there are previous reports of the pest's presence within the state. There are also recent reports of birch casebearer in an area northeast of Sault Ste. Marie in Ontario, Canada, where paper birch decline and mortality was reported after multiple years of defoliation. Caterpillars are protected and camouflaged by small brown cases attached to the surface of leaves. Caterpillars hatch in late summer but overwinter and do most of their feeding the following spring.

Large aspen tortrix

Large aspen tortrix is another native pest in Michigan forests. As the name implies, this pest mainly defoliates aspen trees, but can also impact others like paper birch, willow and alder. The tortrix often defoliates smaller areas than spongy moth and forest tent caterpillar, making it harder to detect through aerial surveys. Many areas of the Lower and Upper peninsulas have documented large aspen tortrix over the last few years. Little damage was mapped in 2023 except in isolated areas of east central Upper Peninsula.



Map depicting 2023 spongy moth damage locations, primarily located in southwest Michigan.

Spongy moth

Introduced to Michigan in the early 1950s, spongy moth didn't become widespread throughout the state until the 1980s. For decades, efforts were made to try to eradicate and control outbreaks. Many methods relied heavily on insecticide use and/or physical destruction of caterpillars and egg masses.

Although these efforts were effective at helping manage outbreaks in localized areas, they were costly, time-consuming and difficult to sustain.

In the 1990s, Michigan introduced a specialized fungus called *Entomophaga maimaiga* that infects and kills spongy moth. Today, with additional help from a naturally occurring virus, other predators and parasites, outbreaks are brief and localized. This "naturalization" has resulted in spongy moth populations behaving like a native pest with limited impacts seen in healthy trees and forests.

Since a statewide peak of 1.4 million acres defoliated in 2021, defoliation dropped to 386,000 acres in 2022 and to 156,000 acres in 2023. Most of the defoliation was mapped in the west and southwest Lower Peninsula where defoliation has only occurred for the past one or two years. Outbreaks typically last up to 3 years, then take 1 to 2 years to fully collapse.

Pockets of localized defoliation can continue as outbreaks collapse, and limited defoliation continued in local areas across much of the Lower Peninsula in 2023. This year, small pockets of defoliation were also mapped in the west central Upper Peninsula. Over the next few years, we continue to expect defoliation levels to drop. Typically, there are 7 to 10 years or more between large outbreaks.

White satin moth

White satin moth is native to parts of Europe and Asia, first detected in the eastern U.S. and Canada in the 1920s. Over several decades, there have been reports of periodic limited defoliation in Ontario, Canada and other areas. We are not aware of reports of this pest in Michigan prior to 2022, when the pest was detected on Isle Royale in Lake Superior.

Infestations on the island may have been related to a small ongoing outbreak around Thunder Bay, Ontario. In 2022, a small population defoliated trembling aspen on Isle Royale.

A white satin moth caterpillar, whith white and red coloring. Image from Bugwood.org.

In 2023, a larger outbreak was observed, beginning at leaf-out in June with defoliation persisting through the growing season. The DNR has not detected white satin moth anywhere else in Michigan.

A forest tent caterpillar and leaf damage.

Forest tent caterpillar

The forest tent caterpillar is native to the eastern United States and Canada, and is often confused with its closely related cousin, the eastern tent caterpillar. Can you tell the difference?

The forest tent caterpillar has yellow dots resembling keyholes along its back, with parallel blue lines along its side. Eastern tent caterpillars have a solid yellow line running the entire length of their bodies. In addition, forest tent caterpillars spin long silky threads and silk mats on trees, while eastern tent caterpillars spin silk tents at branch joints.

In forest settings, forest tent caterpillars primarily feed on sugar maple and aspen, while eastern tent caterpillars feed on cherry, plum, hawthorn and apple species.

Forest tent caterpillar outbreaks tend to last two or three years before populations collapse in response to parasitic flies and other factors. Usually, outbreaks are 8 to 12 years apart. The last notable outbreak across much of northern Michigan peaked in 2018. In 2023, significant defoliation occurred in areas of the central and western Upper Peninsula where defoliation was less significant during the 2018 outbreak.

Customers email with worries about boogeying bugs

Beech blight aphid

“What are those white, fuzzy looking things on my beech tree?” This question came to the DNR from customers across the state in 2023. People wondered if it was a fungus or a spider or something completely out of this world. The strange creature with white, woolly filaments coming out of its posterior is known as the beech blight aphid. It’s a native insect that wiggles and thrashes about quickly when disturbed. The movement looks like dancing, earning them the nickname the “Boogie-Woogie Aphid.” A web search will bring up fun and educational videos of this behavior.

“Boogie-woogie aphids” gather on a beech leaf in the forest.

The aphids themselves are usually harmless, but the mess they leave in their wake can cause trouble. When aphids suck sap from their beech tree hosts, they excrete a sugary waste substance called “honeydew” that will cover anything it lands on, including sidewalks, cars, swing sets and other plants. Because of the sugars in honeydew, ants are usually seen "tending" to the aphids, protecting them so they can eat the honeydew. On a less positive note, black sooty mold fungus also wants the sugars in honeydew. The fungus will grow on patches of honeydew, causing it to look black and a bit fuzzy. Over time, this fuzzy mat will thicken into a brown, furry mass that eventually produces spongy, golden-yellow growths. These can rise 1 to 2 inches above the surface and will eventually turn black again. Observers may see yellow jackets and hornets appear, also looking for a sugary meal.

Despite the dramatic appearance, the long-term impact on beech tree health is minimal. However, those with plants underneath infested trees may want to wash the honeydew off the leaves to prevent the black sooty mold from lessening the amount of light the leaves receive, which can impact the plant's growth.

The cause of beech blight aphid outbreaks is unknown, but they usually last 2 to 3 years before natural controls such as parasites and predators reduce aphid populations.

Insects

Asian longhorned beetle could harm Michigan's maples

Anoplophora glabripennis

The black and white spotted Asian longhorned beetle.

Another year, another pest to keep an eye out for. Asian long-horned beetle threatens a wide range of trees in North America and prefers maples. This beetle has never been detected in Michigan, but the risk is high. We continue to ask everyone to report any suspect insects to the Michigan Department of Agriculture and Rural Development. When detections are identified early, eradication is easier, costs less, and results in a lower impact to ecosystems and managed landscapes.

Adult Asian long-horned beetles are large, glossy black beetles up to 1.5 inches long with irregular white spots and long, black-and-white striped antennae. Although the beetles may be present June through October, beetle damage is frequently noted long before the beetles themselves are seen. These signs include dime-sized scars on tree bark from egg-laying pits, 3/8-inch diameter exit holes (about the size of a pencil), and piles of frass (sawdust-like material) below infested areas. Heavily infested branches are prone to breakage and will display extensive tunneling into the wood. Tree dieback may not occur until after several years of infestation.

Since the first detection of Asian long-horned beetle in North America in 1996, it has popped up in numerous locations. Some infestations in Illinois, Massachusetts, New Jersey, New York and parts of an infested area in southwest Ohio have been successfully eradicated. However, infestations continue to persist in Massachusetts, New York, Ohio and South Carolina. No new infestations have been confirmed in North America since 2020. Eradication efforts continue in these states with good progress toward depleting infestations.

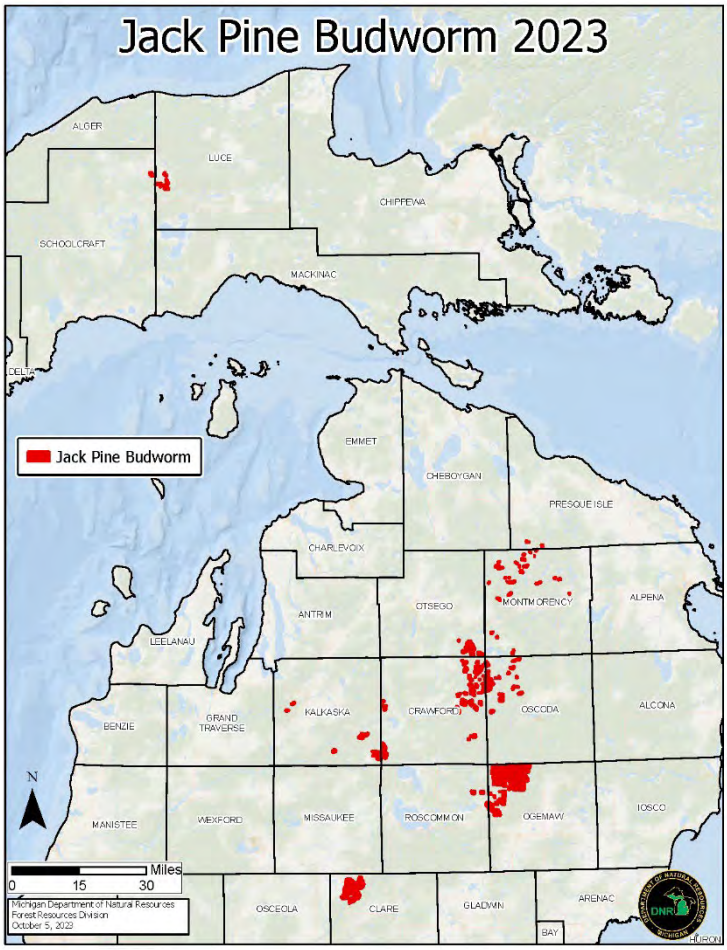
Beetles attack several deciduous tree species. However, its affinity for maple is a major concern to Michigan, both economically and socially. Sugar and red maple are among the most common tree species in Michigan. Sugar maple is a high-quality timber species and is often tapped to make maple syrup. In addition, more than 50% of trees in Michigan cities and towns are maple. Asian long-horned beetle could have severe impacts here in Michigan if allowed to establish itself.

Firewood and packing materials are known to help spread Asian long-horned beetle from one region to another. Help reduce the risk by leaving firewood at home and buying firewood locally to reduce long distance movement of unwanted pests and diseases. The beetle moves slowly on its own and has been successfully eradicated in areas where it was detected early. Observant and knowledgeable community members will be critical in detecting and reporting this pest.

Jack pine budworm outbreak persists

Choristoneura pinus

The native Jack pine budworm continued to cause concern across areas of the northern Lower and Upper Peninsulas in 2023. This Michigan insect cycles through periodic outbreaks every 6 to 12 years. Outbreaks are typically short, building for 2 to 4 years before collapsing to unnoticeable or low levels.



In 2023, an outbreak continued to build in the Lower Peninsula with isolated areas of defoliation occurring in the eastern Upper Peninsula. More than 63,000 acres of defoliation were mapped, in addition to unmapped defoliation on the Huron National Forest. This compares to 28,000 acres mapped in 2022. With two years of defoliation underway, we can expect a natural collapse of the budworm outbreak in the next year or two. The last significant outbreak was from 2012 to 2015, peaking at 118,000 acres of defoliation in 2015. Most of the defoliation was in the northern Lower Peninsula, but a few pockets of damage were mapped in Luce and Schoolcraft counties in the Upper Peninsula.

Jack pines younger than 45 years old typically can withstand severe defoliation over multiple years. Severe impacts in older, over-mature jack pine stands include top-dieback and death. Dieback and tree death can increase fuel loads for wildfires. The most vulnerable stands are those highly stressed due to poor sandy soils and abiotic factors such as drought. Current management practices of harvesting jack pine before they are at risk greatly reduce budworm impacts.

Upper right: Dots on a map indicate jack pine budworm defoliation, primarily in Michigan's northeast Lower Peninsula and in the eastern Upper Peninsula.

Left: Closeup of pupating budworm on a jack pine twig.

Ips bark beetles attack red pine trees

Red pine bark beetles

Michigan has more than 220 million red pine trees, according to U.S. Department of Agriculture's Forest Service. Red pine has been a staple tree species for generations; these trees are important for landscape restoration, timber production and carbon sequestration. In the 1930s, Michigan's Civilian Conservation Corps planted thousands of acres of red pine to reforest areas that were cut or burned. At the time, the Michigan CCC was one of the largest CCC programs in the nation. Now, the DNR annually plants 4 million red pine seedlings to support Michigan's $22 billion forest economy and replant Michigan's forests.

Native bark beetles are tiny, but can cause havoc on weak trees.

Like all tree species, red pine has its share of forest health concerns ranging from Heterobasidion root disease that can kill pockets of healthy trees, to insects that take advantage of stressed trees. Roughly 100 insects are known to feed on red pine, but very few are a threat to healthy trees. However, stressed or dying trees resulting from drought, thinning, windthrow events and diseases are vulnerable to attack by bark beetles and other wood boring insects. One of the most common wood boring insects in red pine are Ips beetles. These native bark beetles take advantage of stressed, dying or dead trees, as well as cut logs and slash (tops and branches) where their populations build. Once populations are at high enough levels, infestations can result in mass attacks of healthy trees, potentially killing them.

In 2023, a series of events raised concern for increased bark beetle damage. A significant drought in the spring set the stage for infestations to build in stressed pine plantations. Routine thinning of drought stressed trees further increased stress. Finally, red pine logs were often left on site for extended periods of time. Bark beetle populations can build in pine logs if left for several weeks or longer in the spring. Beetles can emerge to attack stressed trees and even overwhelm the defenses of healthy trees. These attacks can create pockets of dead red pine in a stand. Once these pockets develop, even with favorable red pine growing conditions in subsequent years, additional damage may occur. In normal circumstances, native Ips bark beetles do not spread widely or kill entire stands.

A forest manager can prevent or reduce bark beetle impacts. If dead trees are present, salvage harvests or removal of infested trees can reduce infestation levels and improve stand health. Good stand management practices that improve tree vigor will also reduce the potential for infestations. Tree removal and replacement may be suitable for older, declining trees or in places with only a few trees.

Surveys and observations over the next few years will help us understand lingering bark beetle impacts resulting from spring 2023. If you manage a stand of natural pine trees or planted pines, monitor for bark beetle infestations and contact a forester for assistance if issues are noticed.

Mountain pine beetle added to state watchlist

Dendroctonus ponderosae

Mountain pine beetle is the newest invasive added to Michigan's watchlist, but it has not been detected here so far. The aggressive, persistent beetle is one of the most destructive bark beetles in the western U.S. and Canada, killing millions of pines during severe outbreaks. It is possible the pest could be introduced via infested pine materials.

It could also spread across the landscape. Climate trends have allowed the pest to move from its range in the western U.S. north into Canada and then east. This gives it a potential path around the pine-free Great Plains to Michigan. Cold winters have slowed the spread but may not be enough to keep it out.

Mountain pine beetle lays eggs under the bark of trees and introduces a blue stain fungus. Larval feeding and fungal colonization can kill a host tree within weeks. Stressed trees are more vulnerable. During drought, populations can spread rapidly.

Bark beetles can mass-attack mature pine trees. These mass attacks have been exacerbated by climate change. Recent outbreaks in the western U.S. and Canada have been attributed to warmer than average winters.

Mountain pine beetle has recently had the largest population explosion ever recorded, causing the death of approximately 125 million acres of North America's conifer forests.

Symptoms of infestation are more common in older pine trees. When beetles enter a tree, the tree attempts to protect itself by extruding pitch. This response produces a popcorn-like protuberance called a "pitch tube" on the tree's trunk.

A pitch tube is a pine tree's resin that is extruded from the beetle's entry point, or attempted entry point, and can be brown, pink, or white. When adult beetles chew into a pine tree, it leaves behind frass, resembling fine sawdust. A common symptom of mountain pine beetle feeding is red frass in bark crevices and around the base of pine trees that have been attacked.

Left: A pitch tube observed on a pine in the Rocky Mountain region. Image by the U.S. Department of Agriculture Forest Service via Bugwood.org.

The beetle is a particular threat in Michigan due to our extensive pine resource. Research indicates that all of Michigan's pine species are susceptible to beetle attacks when stressed; red and jack pine may be particularly vulnerable. Michigan has three native pine species: white, red and jack pine, with introduced scotch and Austrian pine dispersed throughout the state.

White and red pine are keystone conifer species in many forested ecosystems and play major roles in their importance to wildlife and to our economy due to their timber value.

Native pine sawtimber in Michigan is estimated to be worth over $3 billion annually. In addition, jack pines provide critical habitat for the rare Kirtland's Warbler. If mountain pine beetle becomes established in Michigan, we could see significant losses in timber and tourism in addition to impacts on wildlife and changes in unique ecosystems across the state.

This threat to Michigan's pine resource prompted the Michigan Department of Agriculture and Rural Development to issue an exterior mountain pine beetle quarantine in 2020 to reduce the risk of spread. This quarantine mirrors quarantines issued by other Great Lakes states including Minnesota and Wisconsin, assuring uniformity across the region. The quarantine regulates the movement of all firewood and any pine materials with attached bark from the western U.S. and Canada. Exemptions for heat treatments, kiln drying, application of wood preservatives and entry of pine products from non-regulated areas allow for safer trade of pine products.

Mountain pine beetle damage in a pine forest located in the western U.S. Image from Colorado State University via Bugwood.org.

Diseases

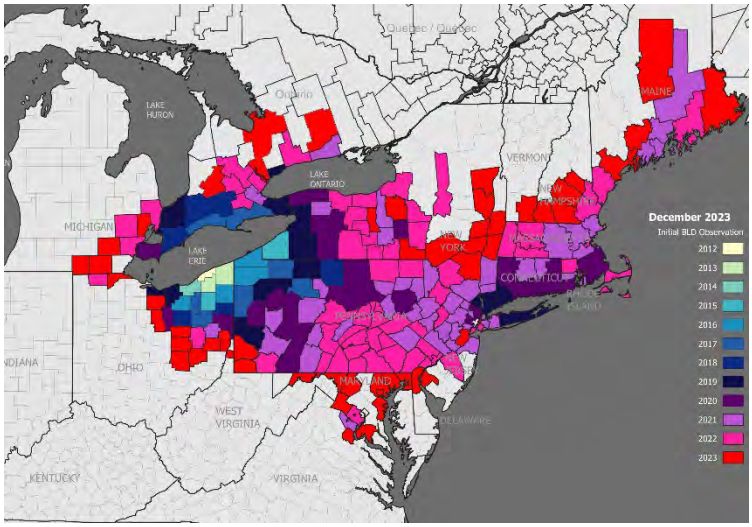
Beech leaf disease expands throughout southeast Michigan

Stella Cousins, Vincent Ader and Jenna Nutter

Beech leaf disease, a recent arrival in Michigan's forests, is now established in southeast Michigan and spreading. The distinctive symptoms of beech leaf disease – darkened interveinal bands on the leaves – were first observed on trees in St. Clair, Oakland and Wayne counties in 2022. The disease may have been developing for several seasons before being spotted, as trees with beech leaf disease typically have an increasing proportion of their leaf areas affected over time. This summer, disease symptoms were observed and confirmed via DNA testing at additional locations in Macomb, Washtenaw, Lenawee and Hillsdale counties.

The dark interveinal leaf bands that indicate beech leaf disease stand out when lit from above in the lower canopy. Washtenaw County, Michigan.

Beech leaf disease poses a significant risk to Michigan's northern forests, where beech is a key part of the ecosystem. It also has the potential to act in concert with beech bark disease.



Map showing beech leaf disease locations by discovery year.

Although beech is more scattered in the southern Lower Peninsula, stands are often found in remnant beech-maple forests, where they anchor important habitats.

Beech leaf disease was first observed and described near Cleveland, Ohio in 2012. While initial spread seemed limited, observations of beech leaf symptoms became much more widespread by 2020, and today trees with symptoms are found in 14 northeastern and Great Lakes states and in Ontario, Canada.

University of Michigan graduate students discuss beech leaf disease and forest health with students in the UM-Dearborn Field Biology course.

Small trees with beech leaf disease typically decline and die over 2 to 6 years, while larger individuals often die but decline somewhat more slowly. Patterns of resistance and mortality are an area of active study.
The disease affects American beech as well as European and Asian species, and ornamental varieties are also susceptible.

Beech leaf disease is closely associated with a nematode that inhabits beech buds and leaves, *Litylenchus crenatae* ssp. *mccannii*. The nematode disrupts normal development of beech buds and may also facilitate infection by one or more microorganisms. Many details of this relationship are still emerging. *Litylenchus* is often found in beech forests with no evident disease symptoms, and whether it always causes beech leaf disease to develop is unknown.

Researchers are also currently investigating a key link in beech leaf disease transmission: the movement of nematode eggs via birds, like the tufted titmouse and purple finch, that eat beech buds and nuts. As we learn more about the natural history of beech leaf disease, we may also discover new ways to slow its pathways and mitigate resulting mortality. Recent work in Michigan on beech leaf disease has focused on detecting the extent and severity of the disease and on increasing public awareness.

In 2023, researchers at the University of Michigan expanded detection and monitoring efforts across southeast Michigan. The team established 19 new long-term monitoring plots in beech stands and conducted detailed surveys along more than 28 miles of trail in public parks and recreation areas. These surveys and plot measurements found 10 previously unknown disease centers occurring in southeast Michigan. Importantly, the long-term plots will also lay the groundwork for understanding how forests affected by beech leaf disease change through time. At this stage, most Michigan locations with beech leaf disease show minor, sometimes barely detectable symptoms.

University of Michigan researchers Grace Bianchi, Vincent Ader and Daniel McConnell survey a stand in Washtenaw County for beech leaf disease.

More than half of understory trees seen with visible symptoms had banding on fewer than 5% of leaves, and 80% of affected canopy trees had fewer than 20% of leaves damaged. However, disease progression in other regions has shown that extensive and severe beech leaf disease can develop rapidly, and that the condition is capable of long-distance spread.

Although controlling leaf-dwelling nematodes at large scales is very difficult, two approaches have shown potential to slow the progression of beech leaf disease in individual, small-diameter trees: a potassium phosphite fertilizer treatment (PolyPhosphite 30 or similar) and a nematicide/fungicide treatment (Fluopyram). Phosphite addition, applied via soil drench, assists a beech tree's defense mechanisms and increases resilience to the nematode, while foliar application of the nematicide targets it directly. Recently, Michigan Department of Natural Resources Forest Health Program staff initiated two demonstration sites for the phosphite fertilizer, and additional trials are planned. At the stand scale, thinning and harvest trials conducted in New York State have not proven effective in slowing beech leaf disease progression.

Tips for spotting and reporting beech leaf disease

Be prepared: Learn about typical BLD symptoms and less serious but similar-looking pests and diseases at Michigan.gov/invasives/id-report/disease/beech-leaf-disease.

Start low: Small trees are often the most severely affected and first to show symptoms. This makes the backlit subcanopy leaves that are visible without binoculars a very good place to investigate first.

Symptoms change with the seasons: Damaged bands are dark at leaf-out, then turn brown and dry before healthy leaves do. They may drop off early. Bands are present at leaf emergence and beech leaf disease is easiest to discern from other forms of leaf damage, such as leaf rolling aphid, in the early summer.

Sanitation: Limit movement of beech wood, leaves and litter as much as possible, including movement of nursery stock. After visiting a site, thoroughly wash boots and equipment used, then spray with alcohol.

Report observations: Take closeup and full photos of affected trees, 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.

Or, download and use the MISIN smartphone app at MISIN.MSU.edu/Apps/#Home.

Diplodia blight reports continue

Diplodia sapinea

Reports of Diplodia shoot blight and canker from previous years continued in 2023. This disease is caused by the fungus *Diplodia sapinea* and related species. Diplodia is common throughout Michigan on many pine species in yards and managed landscapes as well as Christmas tree plantations and natural forested areas. Native red and jack pine can be infected, while native white pine is resistant. Ornamental and invasive species such as Austrian pine, Scotch pine and certain other conifers are susceptible.

A forest health specialist confirms the presence of Diplodia during a site inspection.

Symptoms include a shoot blight, where the branch tips are killed, and stem girdling cankers that kill branches or the main stem of young trees, potentially resulting in deformed surviving trees. Collar rot, or an infection at the base of seedlings, can also cause trees to die.

Most of the time, Diplodia does not cause issues for even-aged, planted red pine stands. However, infected overstory trees and slash (branches and treetops left after logging) can result in infection of young trees and seedlings growing underneath and nearby. Infected trees may show no symptoms until they're stressed by drought or wounded by hailstorms or other events.

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 events that cause stress to trees. These stands should be monitored and overstory removed as soon as regeneration goals have been attained.

Left: Diplodia symptoms including dead shoots and brown needles are observed in young trees.

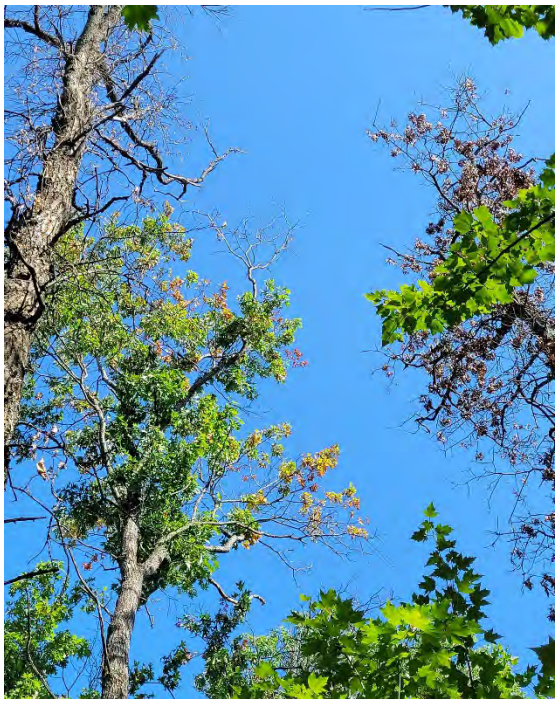
Oak decline on the landscape

Multi-issue complex

In 2023, reports of oak decline continued in the northern Lower Peninsula across land ownerships, following a recent and historic trend.

What is oak decline? It describes a condition when stressed, low-vigor oak trees deal with multiple health issues resulting in tree dieback or death.

A significant amount of oak forest cover-types in lower Michigan experienced consecutive years of ongoing spring defoliation, primarily caused by late spring frost and spongy moth caterpillars feeding. Some stands have had two to three consecutive years of damage. When heavy defoliation occurs in spring, affected trees will usually grow new leaves. After multiple years of damage, efforts to re-grow leaves can deplete the tree's energy reserves.



Trees with oak decline symptoms have patchy, ragged canopies.

Trees were further stressed by periods of seasonal drought. Many oak trees are also reaching 70 to100 years of age or more, growing on nutrient-poor, low-quality sites prone to drought impacts. All these factors further reduce vigor. Trees weakened by these factors become more vulnerable to common native insect and disease damage, including two-lined chestnut borer and Armillaria root rot. Healthy trees are not usually affected by these agents.

Oak decline episodes are regionally common and have occurred periodically over several decades. Forests today grew in the aftermath of widespread logging in the early 1900s, resulting in forests with similar-aged oak trees. Site indexes offer clues as to which stands may be predisposed to decline and mortality in the future. Spongy moth-related defoliation is predicted to subside over the next few years. However, other stressors such as drought and frost that cause defoliation are less predictable. Additional oak decline or mortality may occur in the next few years, but the progress of symptoms will depend on what happens in the future. Recovery may be slow for surviving trees given their ages and situation, particularly among black and northern pin oak which are shorter-lived than other oak species.

Long-term, additional stress events are anticipated and may intensify. Harvests and other treatments that favor younger stands of oak reduces the vulnerability to decline. However, the disturbance created by thinning severely stressed stands prior to recovery can also trigger an additional wave of mortality in mature canopy trees or encourage invasive plants that thrive in disturbed settings.

Oak decline is often confused with oak wilt, a more aggressive but less common oak killer. 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, then expands to form small pockets of dead trees that increase in size over several years.

Invasive plants

Overlooked invasives can hide in our backyards

Much of the work of forest health experts is centered around pests and diseases, from investigating infestations of the tiny hemlock woolly adelgid to treating swaths of forest infected with Heterobasidion root disease. However, the health of a forest also depends on the most obvious component of the forest – the trees! It's easy to forget that some nonnative trees are invasive and can cause harm in forests, reducing yields of desirable native species and weakening ecosystems. Help keep forests healthy: Report invasive species on the MISIN application, review ways to prevent spreading invasives at PlayCleanGo before heading outdoors and replace invaders with non-invasives in your landscaping.

Tree of heaven has chemical properties that push out other trees.

Many invasive trees like tree of heaven and black locust cause problems in forests through chemical warfare. In a phenomenon called "allelopathy," they produce chemicals that disadvantage native plants and trees, making it more difficult for them to grow. These invaders also spread by sprouting new stems from their roots, called "root suckers." These root suckers have ample resources available to them through the established root system of the larger tree, giving them a jumpstart on native seedlings.

Some trees sneak into forests from our own yards and gardens, including invasive Callery pear and Norway maple. These trees are common in yards and as street trees, but you may not notice them escaping.

For example, the often purple-leafed cultivars of Norway maple have seeds that grow into green-leafed trees! A Norway maple can suck up so much water with its roots that it alters moisture levels in the soil.

Right: Norway maples often have dark purple leaves, but can produce offspring with inconspicuous green leaves.

Callery pear often creates thick, thorny thickets that make human and animal passage difficult. Callery pear and Norway maple are both allelopathic.

Scots (or Scotch) pine is a tricky invasive tree in the silvicultural world. In the past, it was often planted for timber production and was once a popular choice for landscaping and Christmas trees. However, its seedlings—and there are lots of them! —often out-compete native red and white pines.

A Callery pear tree infestation forming a tangled thicket near a field.

Black locust can be tricky too. While locust is invasive in Michigan, it is native further south in Ohio and Pennsylvania.

When evaluating impacts of invasive species, timber quality is important to consider. While black locust wood is strong and rot-resistant, the wood of invasive Norway maple is weaker and coarser than native maples, making it less desirable. Callery pear is notorious for its weak wood, often breaking in storms and causing damage to nearby trees, buildings or power lines. Tree-of-heaven wood is reported to cause skin irritation, making it an unwise choice for many applications. Meanwhile, Scots pine can make quality timber when it grows well, but it often splits, curves and is vulnerable to diseases, making it undesirable.

Additional resources:

- Find your regional cooperative invasive species management area: Michigan.gov/invasives/take-action/local-resources.
- Michigan DNR Recommended Trees for Community Planting: Michigan.gov/dnr/managing-resources/forestry/urban/recommended-trees.
- Midwest Invasive Plant Network Control Database: MipnControlDatabase.wisc.edu.
- Alternatives to woody invasives (Woody Invasives of the Great Lakes Collaborative): WoodyInvasives.org.

RIDE CLEAN REPEAT program helps cyclists protect trees

Michigan is home to more than 2,000 miles of state-designated bike trails that span from urban Detroit to the remote forests of the Upper Peninsula, attracting bike riders from across North America.

Mountain biking has grown in popularity over the last few decades, with a spike in new riders occurring over the Covid-19 pandemic as people sought outdoor recreation experiences. The sport is also seeing a broader user base with the increasing use of e-bikes, or bikes boosted with electric power, which allow riders to go further before becoming exhausted and also help people with disabilities access different types of terrain.

With adoption of the sport by growing numbers of people from many locations and lifestyles, it is important to recognize that riders may unknowingly carry invasive plants to new areas, threatening forest health.

RIDE CLEAN REPEAT is a national program bringing awareness of invasive species to riders by describing three steps to take to prevent their spread. It's more than just brushing off your boots!

RIDE: Arrive to the trail with a clean bike and gear, and always stay on designated trails.

CLEAN: Rinse off any dirt or plant debris from the bike before going somewhere new.

REPEAT: Ride the next trail knowing you're free of invasive species.

Much like the well-known "CLEAN DRAIN DRY," campaign that spreads awareness of aquatic invasive species, RIDE CLEAN REPEAT is being adopted by outdoor organizations to keep the land safe from nonnative species that cause harm.

Why is this important? Seeds can blend in with soil and go unnoticed. When even the smallest amount of soil is moved on a boot or bike tire, riders could potentially move a new population of invasive plants to an area.

By taking the time to RIDE CLEAN REPEAT and preventing invasive plant seed dispersal, cyclists can slow the spread of aggressive invasives like buckthorn, Japanese barberry, oriental bittersweet, garlic mustard and Japanese knotweed. Put simply, these preventative measures can help riders protect the places they love, helping preserve ecological health and protecting communities.

Laboratory research and monitoring

Michigan State University – Forest Entomology Lab

McCullough Lab research updates

Deborah G. McCullough

We continue to evaluate conditions in stands dominated by black ash, the most highly preferred and vulnerable host of emerald ash borer. Persistence of black ash, a foundational ecological and culturally keystone species for indigenous peoples, depends largely on tree regeneration following ash borer invasion. Tree ring analysis and 2023 surveys in post-invasion and pre-invasion sites indicate radial growth of young black ash recruits increases notably in post-invasion sites following mortality of all overstory black ash. Unfortunately, nearly half of the black ash recruits in post-invasion sites were dead and about half of the live recruits had signs of ash borer infestation.

Other ongoing projects address hemlock woolly adelgid control, including persistence of two systemic insecticide compounds, and monitoring the condition and radial growth of hemlocks treated with one of these products or left untreated.

We developed a guide for deploying inexpensive sticky traps to capture hemlock woolly adelgid crawlers, the insect's earliest life stage, for detecting new infestations or monitoring recently established infestations. Traps and information were provided to people from Cooperative Invasive Species Management Area groups and other organizations in western lower Michigan where hemlock woolly adelgid poses a major threat to hemlocks in forests and landscapes.

We are also examining options for reducing damage caused by oak wilt and oak wilt mediation. Projects address the ability of fresh stumps to become infected and to facilitate fungal spread among grafted roots. Other projects address how preventive treatments may influence red oak xylem and the trees' vulnerability to fungal growth.

We continue to trap and identify cerambycid (longhorned) beetles in forested and urban sites across Michigan, both to detect any newly established nonnative species and to characterize habitat and hosts associated with native species of this important group of beetles.

Two insect pests, the native chestnut weevil and the invasive Asian chestnut gall wasp, continue to cause serious damage in commercial chestnut orchards. These pests are especially important in Michigan, the leading chestnut producer in North America. We monitored activity, development and distribution of both pests from 2021-2023 to provide guidelines for growers who need to manage one or both insects. We also identified an optimal post-harvest treatment for minimizing damage to chestnuts from weevil larvae without affecting quality of the chestnuts.

Information on spotted lanternfly, an invasive planthopper detected in Michigan in suburban Detroit in 2022, was developed for the MSU lanternfly website. A new bulletin about tree of heaven, the lanternfly's preferred host, was recently posted on the website and can be downloaded for free.

Beech bark disease: Impacts and progression over 20 years

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 inner bark (phloem) of beech trees, was first detected in Michigan in 2000, near Ludington in Lower Michigan and north of Newberry in the Upper Peninsula.

A large canopy cap after death of mature beech trees killed by beech bark disease in the Upper Peninsula.

Beech trees are an especially important resource for many wildlife species who feed on beech nuts, perch on tree branches and use cavities in large trees for dens or nesting. In 2002, we established plots in 62 beech stands (28 and 34 sites in the Lower and Upper peninsulas, respectively) to monitor BBD progression and impacts. At that time, only 37% of sites had beech scale and there was no evidence of any beech bark disease-related mortality. When these sites were revisited in 2012-2013, beech scale had spread into the central Upper Peninsula and across the northwest Lower Peninsula. Beech trees had begun dying from the disease in the U.P. but there was negligible beech mortality in the Lower Peninsula.

We re-surveyed 60 of the original 62 sites in 2021-2023 (two U.P. sites were inaccessible) to document variables including presence of beech scale, overstory trees (species, size, basal area, canopy condition), regeneration (species, density) and coarse woody debris. While 23 sites had beech scale in 2003, this invasive insect has now invaded 59 of the 60 sites. The remaining uninfested stand is in Saugatuck Dunes State Park, the most southern of the original sites.

Across all 60 sites, the proportion of beech basal area killed by beech bark disease has increased from 5% in 2003 to 24% in 2013 to 36% as of 2023. An average of 58% and 22% of beech basal area is now dead in the U.P. and Lower Michigan sites, respectively. Density of beech saplings more than doubled between 2013 and 2023, especially in the U.P. where undesirable “beech thickets” caused excessive stump and root sprouting following death or removal of large beech trees.

At least 10 foliage samples were collected from beech trees in all 60 sites and screened for beech leaf disease. None were positive, which is at least some good news for the beech resource in Michigan.

A MSU technician measuring fresh beech coarse woody debris at a beech bark disease impact site.

Michigan State University – Forest Pathology Lab

Five Caliciopsis species found in Michigan forests

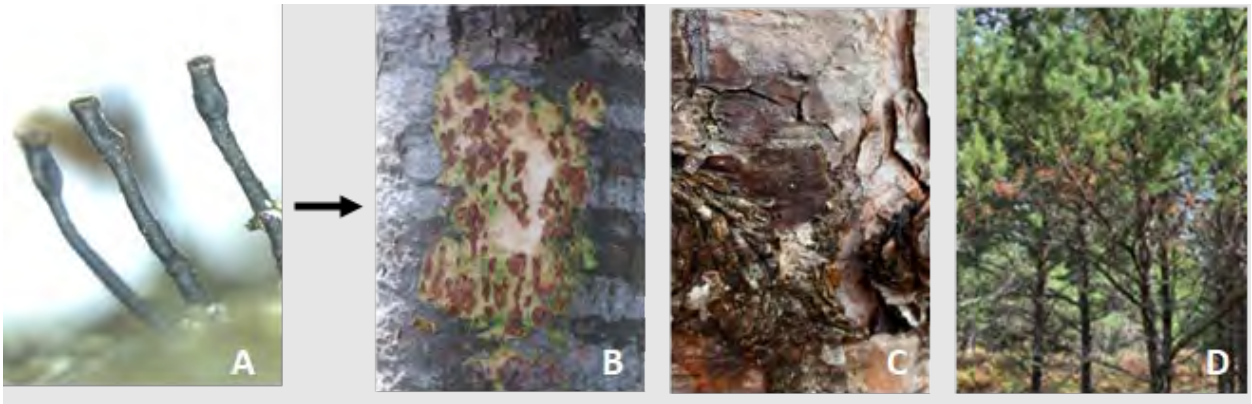
Rebecca J. Harkness and Timothy D. Miles

The fungus Caliciopsis pinea causes Caliciopsis canker disease of white pine. Infected white pines may exhibit wood discoloration, pitching and profuse resin bleeding, and flagging of lower branches. Bark fissures form on the trunk and become increasingly dramatic with recurring infections. These infections increase the risk of secondary infections by other pathogens or insects.

Observations of more frequent and severe disease on white pine have been attributed to environmental conditions that result in drought (poor soil quality, overstocking, changing climates, etc.). Recent observations of disease note that the disease can be more aggressive than previously documented. Mortality of seedlings was even reported in severely infected sites. Such disease observations have been spreading steadily throughout the white pine's native range.

Research efforts at Michigan State University have focused on understanding the diversity of Caliciopsis species present in Michigan and developing molecular tools to diagnose and detect it. To date, five species of Caliciopsis have been identified in Michigan, only two of which are formally described. *C. pinea* has been known to cause disease on Michigan white pine since 2017, but *C. moriondi* was newly identified as infecting red and jack pines in the state. Three undescribed species of Caliciopsis were also isolated from white pine, red maple and black oak. We are concerned about the threat these new species pose to Michigan's forests.

All three pines native to Michigan are susceptible to Caliciopsis canker disease, and the impact of undescribed Caliciopsis species on hardwood hosts is still unknown. The five trees that host a Caliciopsis species pose considerable economic, social, and ecological value to the state. They collectively represent millions of acres of forested land in public parks and managed forest ecosystems. Research on threats to the health of these species is critical for the continued success of Michigan's forest products, and parks and recreation industries.



Examples of damage to various hosts caused by Caliciopsis species.A) An example of a Caliciopsis ascocarp. B) Wood discoloration on white pine. C) A pitching canker with Caliciopsis ascocarps at the margin on a red pine. D) Flagging of lower branches on a jack pine with Caliciopsis infection.

Michigan Technological University – Bal Forest Health Lab

Bal Lab research updates

Tara L. Bal

Graduate student Shelby Lane-Clark drills a maple tree to collect sap along an invasive earthworm gradient.

The Bal Lab specializes in forest health monitoring, aiming to provide problem-solving strategies to manage forest health issues that affect Michigan forests and the forest products industry. Its research programs span issues related to entomology, pathology, and forest ecology. The lab is currently working on projects associated with oak wilt, beech bark disease, maple dieback, and invasive plant species, as well as socio-cultural drivers that influence the management of forest health issues.

For example, we've found that presence of invasive exotic earthworms is negatively correlated with overall sugar content in an assessment of maple sap chemistry along gradients of earthworm establishment. We've also conducted online surveys of forest managers to better understand perceptions related to sugar maple canopy dieback in Michigan. Results from these studies and others will help forest managers understand long-term forest health management strategies and better risk assessments.

Myco-biocontrol assessment of invasive buckthorns using a native fungus

Tara L. Bal, Sigrid Resh and Abraham Stone

Student research assistant Abraham Stone counting inoculated buckthorn stems in a late-season survey.

We have been investigating use of a native fungus, *Chondrostereum purpureum*, as a mycobiological control on the significant forest invaders glossy buckthorn, *Frangula alnus,* and common buckthorn, *Rhamnus carthartica*, in collaboration with the Keweenaw Invasive Species Management Area (KISMA).

After just one field season, a gel application on cut stumps of the fungal treatment was as effective as glyphosate at reducing buckthorn stump sprouting up to 80%.

C. purpureum is a native pathogenic fungus known to cause silver leaf disease, named because of progressive silvering of leaves in affected trees, especially in cherries and plums. The fungus has airborne spores but can only infect living trees from open wounds. Trial studies have confirmed *C. purpureum* can be used as a biocontrol agent (greater than 60% mortality) on buckthorn and other hardwood species when directly applied, though it is not widely used or available as an alternative product in the U.S.

Our current research efforts have expanded on these studies and are set up for longer-term monitoring of resprouts and mortality. Trials established include comparisons between different buckthorn species after gel-inoculation, as they develop symptoms of infection over time. We are also testing deployment methods of diluted liquid *C. purpureum* sprays on mowed thin whips of young buckthorn. The development of a myco-biocontrol for buckthorn will provide a desired alternative when chemical control may not be an option.

Gel application of C. purpureum into buckthorn trunk.

Oak Wilt: Examining insect visitation to improve detection and management

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

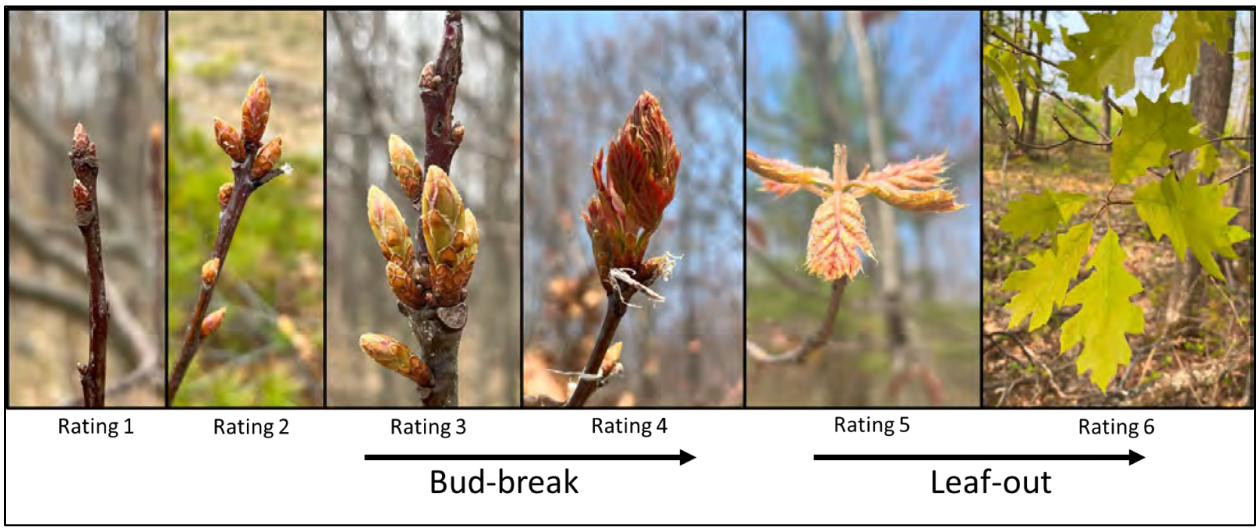
Oak wilt is found throughout much of the Lower Peninsula but only found in three counties in the Upper Peninsula, bordering Wisconsin. Despite susceptible host trees, native vectors, and local wood movement, the disease has not been detected across most of the Upper Peninsula. Since 2021, we have been conducting a collaborative study to evaluate timing and relationships between hosts (oak trees), vectors (nitidulid beetles), and environmental variables to better understand risk of northern oak wilt expansion in Upper Michigan and Canada.

We've monitored weather variables, collected nitidulids from flight traps baited with pheromones or bread dough and artificially wounded oak trees to monitor visitation by nitidulids across sites in the Upper Peninsula (including a stand with oak wilt in Iron County).

Left: Graduate student Katie Bershing uses an aspirator to collect beetles from artificial wounds in trees.

Partners conducted a similar study in eastern Canada using the same protocols. There are more than 100 nitidulid species across this region.

Information about the beetles' wound visitation and flight activity is crucial to effective management and detection strategies. In 2023, bud break and leaf out were recorded at the same time as oaks were wounded. Preliminary evidence suggests that the risk of oak wilt infection is low before bud break.



Bud-break and leaf-out ratings are used for oak canopy assessments.

Beetles aren't visiting fresh wounds before this time, when wounds are less than three days old, which is a critical time-period for infection to occur. The highest risk appears to occur between bud break and July 31, when beetles are actively flying and visiting wounds, and host tree susceptibility to infection is greatest due to early wood development. Risk decreases after July because the host becomes less susceptible during late wood development and flight activity decreases for two of the three suspect vectors. Another season of collecting data is planned to confirm these trends.

These finding have implications that could result in refining the overland spread risk and no-pruning guidelines for Upper Michigan, especially in light of climate change affecting timing and behavior of beetles responsible for overland spread.

Contact and acknowledgements

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Cover photo: Hemlock woolly adelgid monitoring in November 2023.

Nondiscrimination statement