



United States Department of Agriculture



Michigan Department of Natural Resources

Michigan Forest Health Highlights 2020

Michigan Department of Natural Resources, Forest Resources Division



Introduction

The value of trees became apparent in 2020 like no other year. People turned to the outdoors for recreation and peace of mind. They grew more interested in local surroundings as they spent an increasing amount of time outdoors and sent record numbers of questions about backyard trees to Michigan Department of Natural Resources staff. They also purchased loads of lumber to embark on home improvement projects.

Michigan's nearly 20 million acres of forest land are essential and provide substantial value to our state. Forests create places to explore, jobs and raw materials. They provide clean air and water and even boost our physical and mental health when people visit them to hike, hunt, bike, fish, ski or birdwatch.



With that value in mind, partnerships among government agencies, universities, local action groups and the community are key in preventing pests and diseases that threaten Michigan's trees and forests.

In 2020, our work in the DNR Forest Resources Division was profoundly complicated by the effects of COVID-19, a common issue in many professions. Despite the difficulties introduced by the pandemic, Michigan's forest health partners devised creative solutions and stepped up to the challenge of continuing to protect our forest resources.

Crews scoured wooded areas along the Lake Michigan coast for the tiny hemlock woolly adelgid insect, identified and planned treatments for new pockets of Heterobasidion root disease – a fungus attacking red pines – and tested new ways to fight the devastating oak wilt disease. With agency partners, quarantines were established to protect forests from new threats and community members were educated on how to keep a watchful eye on their trees close to home.

The DNR's Forest Health Team and its many partners are committed to caring for Michigan's forests so everyone can enjoy their benefits now and into the future. Thank you to our partners for their dedication to protecting forest resources, and to readers for your interest Michigan's trees and forests.

Sincerely,

Jeff Stampfly

DNR Forest Resources Division Chief and State Forester

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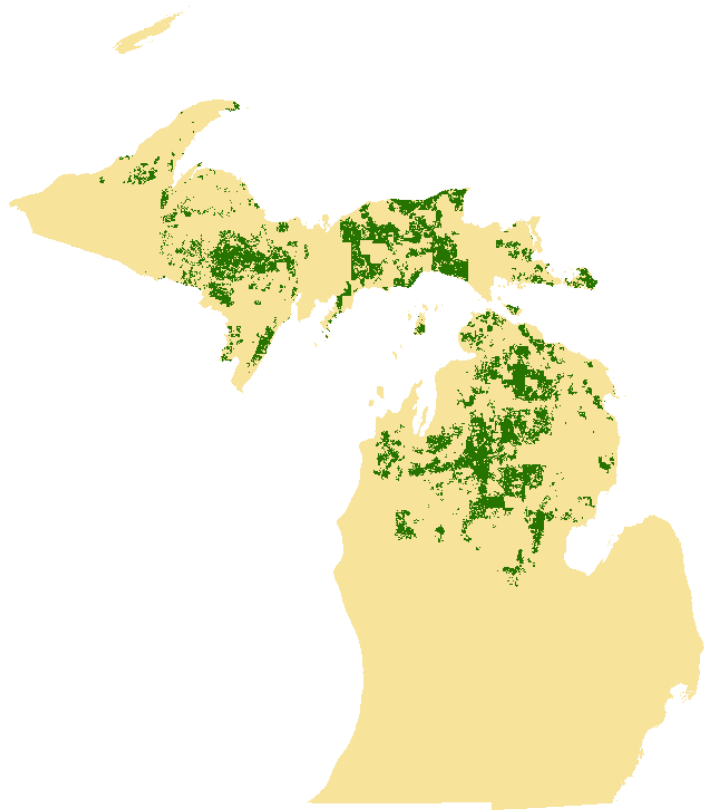
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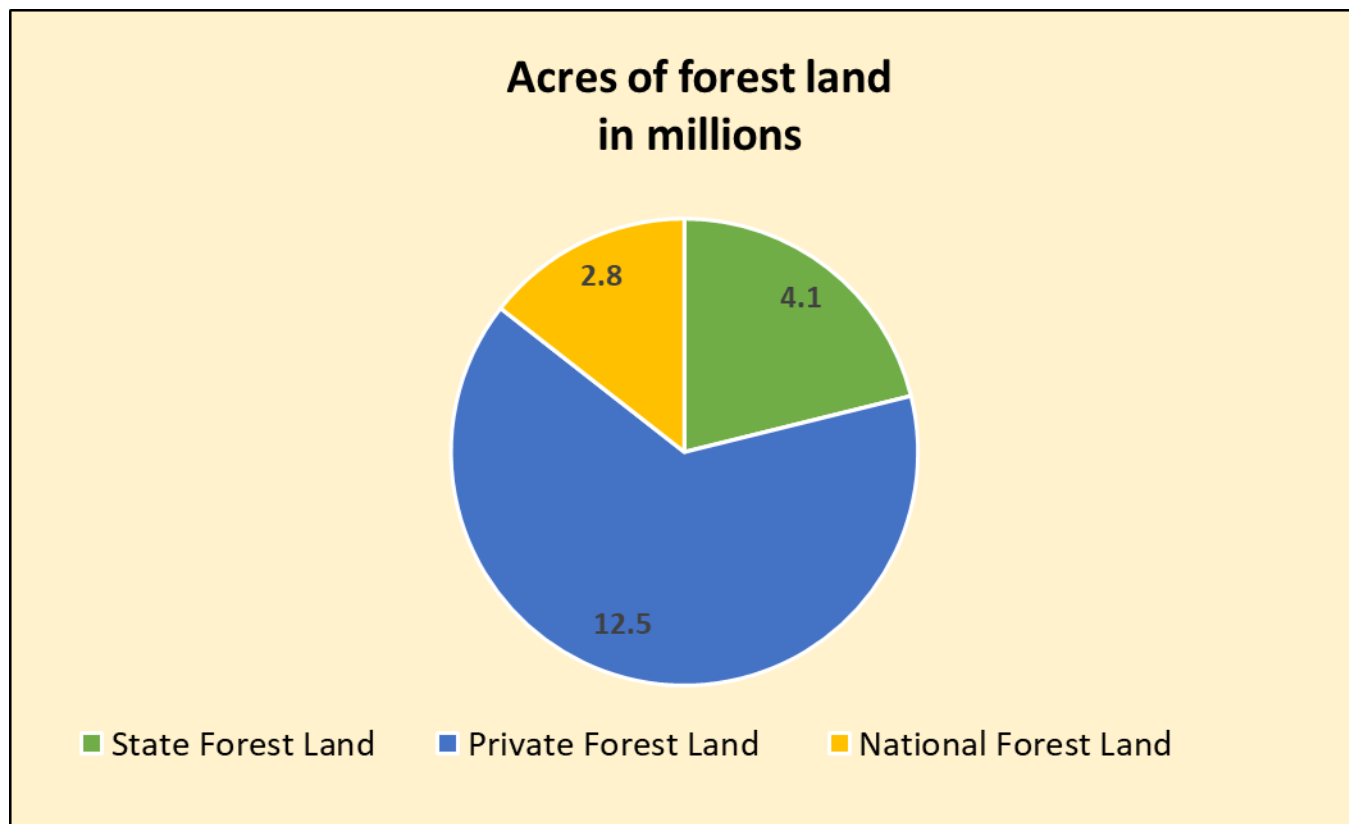
Michigan's forest resources

Forest resource summary

From verdant upland hardwood forests to cool cedar swamps to sun-drenched oak savannas, Michigan's 19.3 million acres of forestland, about 4 million of which the DNR's Forest Resources Division manages, play an important role in the Michigan way of life. Michigan's forests are the heart of a \$20 billion forest products industry and a \$34 billion outdoor recreation industry (*learn more at Michigan.gov/DNR*). Most of the state's large forests are in the Upper Peninsula and northern Lower Peninsula. Monitoring and protecting this resource from the effects of forest pests and diseases is an important part of ensuring that we can enjoy the benefits of forests today and into the future.



State-managed forest lands in Michigan are located primarily in the Upper Peninsula and northern Lower Peninsula.



Michigan forest land ownership

Weather conditions

Weather effects: Ice, frost and rising waters

Climatic extremes are taking a toll on Michigan's trees. The eastern Upper Peninsula experienced a heavy snow and ice storm at the end of December 2019, which left downed trees across roads and trails and created extensive power outages.

Long-term impacts to damaged trees depend on the extent of the damage. Younger, more vigorous deciduous trees will be able to replace lost crown area quickly and wall off damaged areas, preventing diseases and insects from taking advantage of open wounds. Stressed trees may struggle. However, lasting impacts to young pines were particularly significant in areas of Chippewa and Luce Counties. Some trees lost central leaders, the important vertical stem at the top of the trunk, permanently altering their form. Small trees were pressed toward the ground under the snow, creating small wounds that resulted in infection and subsequent dieback or death due to a fungal disease called Diplodia.

Just as Michigan's oak trees were breaking bud in late May 2020, they were hit with a severe widespread frost when overnight temperatures fell into the low to mid-20s for two to three consecutive nights across much of the Lower Peninsula. Damage was reported from the 45th parallel south to the Ohio state line, with reports of localized damage in the Upper Peninsula. Trees appeared ragged, with thin crowns, as leaves struggled to emerge from the damage. Heavily impacted trees tapped into stored resources and produced a second flush of leaves. In many cases in southern Michigan, these leaves appeared to be yellow in color and not the normal deep green typical in oaks. While frost damage alone is not enough to kill trees, the stress can predispose older oak trees to crown and branch dieback or severe nutrient deficiency, particularly when combined with other stressors like defoliation by insects or drought.



Frost damage made some trees appear ragged and thin.



High water levels have impacted shorelines statewide. Photo of Lake St. Clair from Michigan Department of Environment, Great Lakes and Energy.

In addition to cold-weather events, Michigan water tables continued to rise in 2020. Many waterfront property owners reported dying trees that had previously appeared to be perfectly healthy. Upon further investigation, it was discovered that most of these trees were near the lakeshore. Rising water tables were effectively drowning the trees' root systems. In other lowland areas of the state, large numbers of trees have died or are dying as well, either as a direct result of the high water or in combination with insects and diseases taking advantage of stressed trees.

Aerial surveys

In a typical year, the DNR's Forest Health Program surveys much of Michigan's nearly 20 million acres of forest land for insect and disease damage. These surveys occur throughout the growing season, in cooperation with the U.S. Department of Agriculture Forest Service, which conducts aerial surveys on national forest lands. Aerial surveys for many pests and diseases must occur during peak defoliation, which is only visible for a period of weeks before new foliage growth masks their effects.

Large areas of defoliation, discoloration, dieback and mortality are mapped during aerial survey missions. Aerial survey information is used to monitor damage and changes in pest populations from year to year and serves as an early detection tool for emerging problems. Foresters, other natural resource professionals and policy makers use this information to make decisions that improve the growth and health of forests.

Things changed dramatically in 2020 in the face of the COVID-19 pandemic. DNR Forest Health staff did not get clearance to return to field work until early June, and that approval came with many restrictions. Most survey efforts were conducted from the ground following up on reports from foresters, cooperators, and private landowners. It quickly became apparent that there was a widespread gypsy moth outbreak occurring in oak trees in the Lower Peninsula and that spruce budworm damage was ramping up across much of the Upper Peninsula. Attempts were made to use remote-sensing models and satellite data to define and map damage using alternative methods. However, none of these approaches felt accurate or up to the standards we would attain using aerial survey mapping. As the window to map defoliation began slipping away, we still did not have clearance to fly due to the pandemic.

Racing against the clock, forest health specialists worked with aviation managers to develop an acceptable protocol to allow the DNR to fly with restrictions in order to map the historic levels of gypsy moth damage that were occurring. The protocol, approved in late July, included only two occupants in the aircraft rather than three – a pilot and surveyor – to minimize staff contact. The surveyor wore a mask and sat in the back seat away from the pilot. Airflow was maximized through the cabin with vents fully opened and the flight duration was reduced to two to three hours. Staff logged 20 hours of flight time over the following week and were able to capture the extent of gypsy moth damage across the Lower Peninsula. Unfortunately, we were too late in the season to map damage across the Upper Peninsula. The total area flown amounted to approximately 40% of a normal survey season.

Insects

Asian longhorned beetle - *Anoplophora glabripennis*

The Asian longhorned beetle was detected near Charleston, South Carolina this year, making it the sixth U.S. state to find this invasive pest. It was first noticed by a resident who reported it to local authorities. As of fall 2020, more than 3,000 infested trees were detected within a 58-square-mile area of Charleston County.

The beetle has not yet been detected in Michigan. However, these beetles infest several hardwood species, including maple, a particular concern for Michigan.

More than 50% of trees in our state's cities and towns are maple species. The good news is that the beetle moves slowly and has been successfully eradicated from areas where it was detected early.



A distinctive black-and-white spotted Asian longhorned beetle



The Asian longhorned beetle's pencil-shaped exit hole

The large, glossy, black adults – up to 1 ½ inches long - have irregular white spots and long, black-and-white striped antennae. Rather than spotting the beetle, often the first signs of it are the symptoms of infested trees. Symptoms include dime-sized scars on the bark from egg-laying pits, 3/8-inch diameter exit holes about the size of a pencil, and piles of frass (sawdust-like material). Heavily infested branches are prone to breakage and will display extensive tunneling into the wood of the tree. Observant, knowledgeable residents will be critical in detecting and reporting this pest early for successful eradication.

Moving firewood and transporting the insect in packing materials is a major concern for dispersal of this insect. Surveys are conducted annually in state

parcs and recreation areas in cooperation with the DNR's Parks and Recreation Division and community volunteers to raise awareness. Training of arborists, foresters, other natural resource professionals and volunteers continues.

If you find anything you suspect may be an Asian longhorned beetle, collect the beetle if you can and report it to 1-800-292-3939 or MDA-Info@Michigan.gov.

Balsam woolly adelgid - *Adelges piceae*

Balsam woolly adelgid is a close relative of hemlock woolly adelgid and causes similar losses in true firs. North American species such as balsam fir and Fraser fir are susceptible to attack. European species appear to be tolerant but can harbor it, while Asian fir species have intermediate resistance. Douglas-fir, which is not a true fir, is not attacked by balsam woolly adelgid.

This tiny pest is native to Europe and is thought to have entered the northeastern U.S and southeastern Canada on infested nursery stock around 1900. It is now found in eastern and western North America. It is established in California, Idaho, Maine, New York, North Carolina, Oregon, Tennessee, Vermont, Virginia and Washington in the United States; and in British Columbia, Newfoundland and Quebec in Canada. While its distribution appears to be limited by cold weather, the fact that it occurs in Idaho, Maine and Vermont indicates potential for establishment in Michigan.

The balsam woolly adelgid is a wingless, soft-bodied insect related to aphids. When the eggs hatch, the "crawlers" are mobile only for a short period of time before attaching to a host with their mouthparts. Crawlers disperse short distances through their own movement and longer distances by wind, birds and



*Balsam woolly adelgid produces gouting on twigs.
Image via Bugwood.org.*

mammals. Humans aid the dispersal of adelgids through movement of infested materials such as firewood.

When balsam woolly adelgids feed, they inject a salivary substance into the tree, causing gall-like structures and calluses to form on branches and twigs, sometimes called “gouting.” Heavy stem infestations can kill a tree in two to three years, while crown infestations cause progressive decline.

If the balsam woolly adelgid were to become established in Michigan, it would adversely affect the timber, nursery and landscaping industries as well as the Christmas tree and tourism industries. The Michigan Department of Agriculture and Rural Development implemented a balsam woolly adelgid quarantine in 2014, regulating the movement of true firs entering the state from other parts of the U.S. and from Canada. The balsam woolly adelgid quarantine generally prohibits movement of fir nursery stock and timber products originating from infested areas. Exemptions include seedlings and transplants less than 3 years of age. Cut fir Christmas trees, wreaths and boughs are exempt during the period of Nov. 1 - Jan. 31.

Gypsy moth - *Lymantria dispar dispar*

European gypsy moths were the talk of the town in the northern Lower Peninsula this year as nearly 1 million acres were defoliated. Michigan has not seen this much defoliation since the early 1990s when populations last exploded.

Introduced in the early 1950s into southern Michigan, gypsy moths spread like wildfire and can be found throughout the state today. Unlike the defoliation in the 1990s, today’s outbreaks are typically brief and localized due to the introduction of *Entomophaga maimaiga*, a fungus that only infects and kills gypsy moths.

Coupled with native predators, parasites and a virus that targets gypsy moth populations during outbreaks, gypsy moths are now considered “naturalized” into Michigan’s forests. Consequently, they now behave more like native pests such as forest tent caterpillars. Outbreaks still occur but now are usually related to weather such as drought or other tree stressors that allow populations to build.

In 2016, 2017 and the summer of 2018, drought plagued Michigan, allowing gypsy moth populations to grow. In 2019, much-needed rain brought a significant collapse of populations throughout southern Michigan. However, the northern Lower Peninsula did not fare as well, and over 200,000 acres were defoliated. With fewer rainy days and long hot dry spells in 2020, gypsy moth populations continued to thrive in the northern Lower Peninsula, and nearly 950,000 acres were defoliated.

Most healthy deciduous trees can withstand severe defoliation from gypsy moth attacks for a few consecutive years with no long-term impacts. Trees in forests and backyards generally recover, re-leafing later in the summer. Trees subject to drought or other stressors may start to die after a few years of consecutive defoliation. However, after a few years of high activity, gypsy moth populations are likely to collapse without human intervention. To help high-value trees survive, deep watering during extended dry spells is the most important action to take. A light fertilizer application in late fall can also help trees rebound from stress caused by gypsy moth feeding.

Hemlock woolly adelgid - *Adelges tsugae*

Introduction



Tiny hemlock woolly adelgids can be identified by whitish ovisacs on twigs at the needle base.

Hemlock trees across the eastern United States have been under threat by hemlock woolly adelgid since 1951, when the tiny insect was first observed in Virginia. Millions of eastern and Carolina hemlocks have been lost over the last few decades as the hemlock woolly adelgid range has grown north to Maine, south to Georgia and from the Atlantic Ocean west to Kentucky and Tennessee.

Limited hemlock woolly adelgid infestations also have been found in the western Lower Peninsula of Michigan and in the provinces of Nova Scotia and Ontario. Trees usually die after four to 10 years of infestation.

In Michigan, the tiny, sap-sucking insect was first detected in 2006. However, the extent of establishment was not recognized until 2016. To date, hemlock woolly adelgid infestation in Michigan is contained to about 100 miles along the Lake Michigan shoreline ranging from Allegan County north into Mason County.

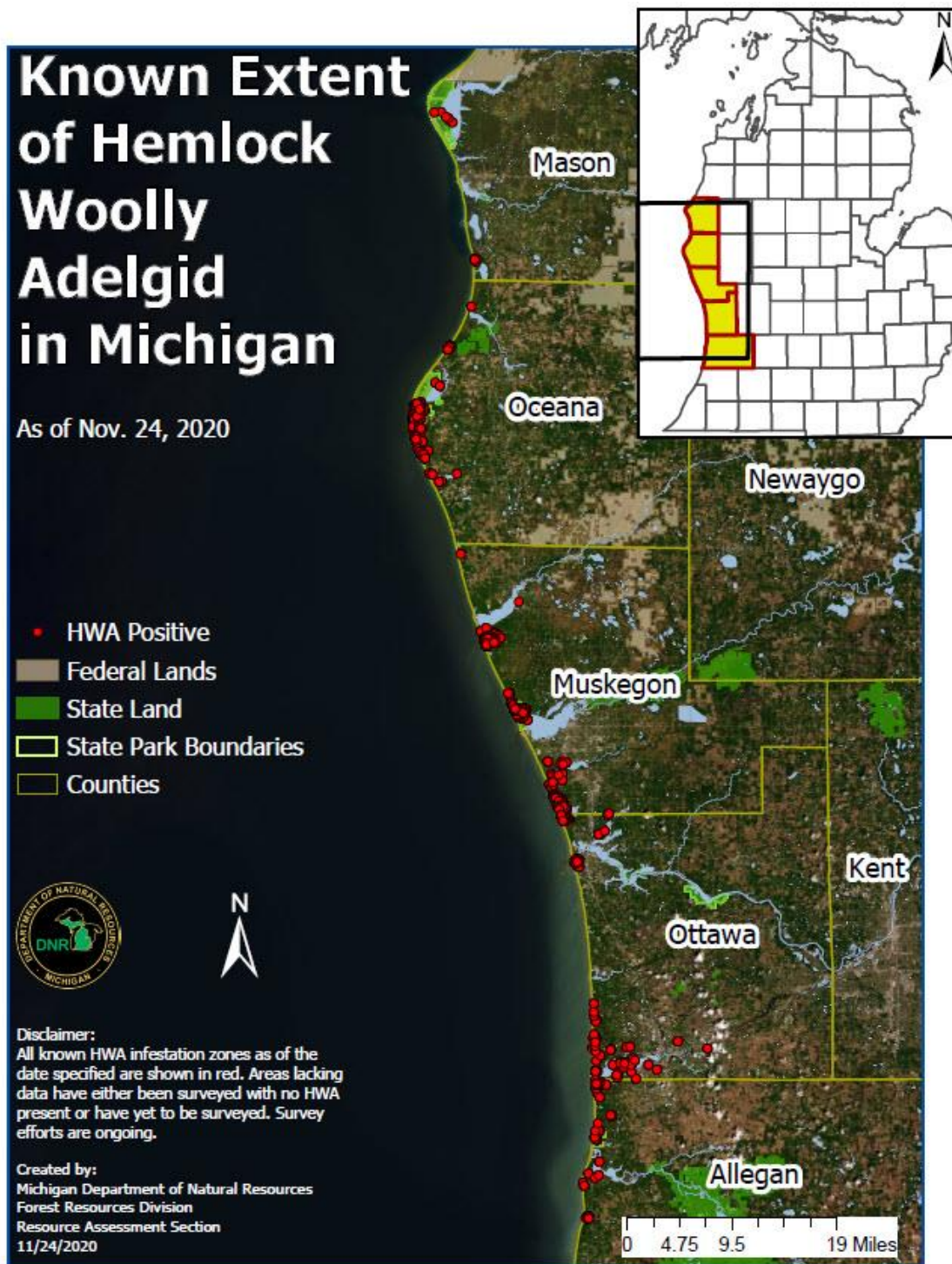
Extensive surveys are ongoing to maintain confidence regarding distribution in Michigan. Unfortunately, in October 2020, infestations were found in Ludington State Park, extending the range farther north.

Michigan's forest ecosystems are home to roughly 176 million hemlock trees. Hemlocks may be continuous throughout a stand or scattered understory trees in mixed hardwood stands. They play a critical role in every place they live. Some stabilize dunes by growing on steep, sandy soils where few other species of trees can thrive. Others provide wildlife habitat, supporting rare species of birds and fish that rely on high-quality waters made possible by hemlocks along riverbanks. Hemlocks play a key role in microclimates used to regulate stream temperatures for fish such as trout, which require cool water during the hot summer months.

To mitigate the risk of introducing hemlock woolly adelgid, MDARD established an exterior quarantine in 2001. Small, localized infestations observed from 2006 to 2013 were successfully eradicated. However, through continued public awareness campaigns, hemlock woolly adelgid observations increased in western Michigan. By 2017, established pockets of hemlock woolly adelgid were observed in Ottawa County. The first detection on state-managed land was found at P.J. Hoffmaster State Park.

Densities along the 100 miles of 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 do not grow farther south or east of the current infestation and to the west lies Lake Michigan. This allows forest health staff to focus containment efforts on the northern extent of hemlock woolly adelgid, directly protecting most of Michigan's hemlocks, which grow in the northern lower and upper peninsulas.

A coordinated statewide strategy to manage hemlock woolly adelgid infestations was implemented in 2017 by the MDARD, the DNR, the USDA Forest Service, Michigan State University and Ottawa County Parks and Recreation. Priorities include prevention, detection, management and monitoring.



Prevention

MDARD enacted an interior state quarantine effective July 5, 2017, revised in 2020, that restricts movement of hemlock materials out of and within the five infested counties (Allegan, Mason, Muskegon, Oceana, Ottawa). Hemlock nursery stock and processed products containing hemlock twigs and needles, such as branches, boughs, logs, lumber and firewood, are covered by the interior quarantine.

MDARD also maintains and enforces the exterior quarantine aimed at preventing new introductions of hemlock woolly adelgid from outside the state. The department also implements a nursery program that may authorize growers and dealers to ship hemlock nursery stock out of and within regulated counties. Agreements are in place with 26 Michigan firms.

Detection and monitoring

Land 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. The Forest Health Program within the DNR's Forest Resource Division created a response team to detect, manage and monitor pests and diseases in Michigan forests in 2018. Its primary objective is to help implement the hemlock woolly adelgid statewide strategy, with a focus on federal and state land survey, as well as treatment and outreach.

Since 2018, the team has surveyed in 23 counties and has tracked contact with more than 1 million people through the statewide program and its partners. In February 2020, the crew discovered three new infestations, two in northern Oceana County just south of Mears State Park, and one just inside Mason County near Bass Lake. That was the northernmost point of detection until the discovery in Ludington State Park in October. One of the northern Oceana County infestations was the first detection on DNR-managed property at Pentwater State Game Area.



A surveyor uses a hand lens to inspect for adelgids.

The DNR Parks and Recreation Division took the lead on state park land. Based on surveys conducted from 2017 to 2020, hemlock woolly adelgid has been detected at eight state parks on Michigan's west coast: Saugatuck Dunes, Holland, P.J. Hoffmaster, Muskegon, Duck Lake, Silver Lake, Charles Mears and Ludington. With funds from sales of the Recreation Passport, user fees and a partnership with AmeriCorps, the DNR established a year-round Michigan Civilian Conservation Corps forest health crew to focus on hemlock woolly adelgid survey and treatment. From 2018 to 2020, the crew tracked over 6,000 miles through almost 19,000 acres of Michigan state parks. They found more than 7,000 infested trees within the quarantined counties. Parks surveyed outside the quarantine area include: Warren Dunes, Warren Woods, Grand Mere, Van Buren, Petoskey, Young, Traverse City, Leelanau, Old Mission,

Ludington, Orchard Beach and portions of Tahquamenon Falls state parks and Van Buren and Kal-Haven linear trails. Ludington State Park will soon be added to the quarantine as hemlock woolly adelgid was detected there in late October 2020.

The Michigan Invasive Species Grant Program and the Great Lakes Restoration Initiative funding provided for surveys by The Nature Conservancy and local Cooperative Invasive Species Management Areas (CISMAs) on private and local public lands. Two separate efforts are under way. West Michigan CISMA has surveyed land around Silver Lake, Cedar Point Beach Park, Mears State Parks, and near Bass Lake. Additional private land surveys were conducted within 5 miles of the Lake Michigan shoreline farther from known infestations by TNC and local CISMAs in both the lower and upper peninsulas.

Since 2018, no infestations have been detected outside of the five quarantined counties.

Overall survey acres by partner

	Winter 2019-2020		2018 to Present	
Land Ownership	Detection Survey Acres	Counties Surveyed	Detection Survey Acres	Counties Surveyed
Federal and State*	555	11	1,489	23
State Parks	16,276**	12	18,993**	14
Private and Local Public	5,814	22	10,906	22
Totals	22,645	28	31,388	31

* State land except state parks

** Some high-value acres were surveyed more than once.

Treatment

Extensive surveys indicate the statewide hemlock woolly adelgid strategy remains on track. To slow the northward spread of hemlock woolly adelgid, the DNR has partnered with the West Michigan CISMA and North Country CISMA to suppress hemlock woolly adelgid populations on private land in Oceana and Mason counties. On private land surrounding Mears, Silver Lake and the north side of Bass Lake state parks, staff have treated more than 50,000 hemlocks since 2018. In addition, the DNR continues to manage and treat hemlock woolly adelgid in state parks. In 2020, Civilian Conservation Corps crews treated an additional 11,049 trees.

Treatment progress by partner

	2020 Treatment Seson			Overall Treatment Since 2018		
	Hemlocks Treated	Treatment Inches	Acres Treated	Hemlocks Treated	Treatment Inches	Acres Treated
Land Ownership	Hemlocks Treated	Treatment Inches	Acres Treated	Hemlocks Treated	Treatment Inches	Acres Treated
Federal & State*	No HWA treated	No HWA treated	No HWA treated	No HWA treated	No HWA treated	No HWA treated
State Parks	11,049	68,862	560	31,062	191,451	1,973
Private and Local Parks	21,947	141,040	1,819	50,456	332,885	3,141
Totals	32,996	209,902	2,379	81,518	524,336	5,114

* State land except state parks

Collaboration

In July 2020, the sixth annual Hemlock Woolly Adelgid managers meeting was hosted online where state, federal and international agencies from eastern North America met with researchers, private industry and municipalities to share hemlock woolly adelgid-related experiences. The meeting is a valuable opportunity to share information.

Hemlock forecast

Infestations in Michigan are relatively contained, with most of the hemlock range in the state separated from known infested areas. Treatment options exist and can be implemented over a broad scale within infested sites. In addition, the hemlock woolly adelgid appears to be susceptible to extremely cold winter temperatures, and it is possible that the insect may not survive winter in Michigan's northern and inland forests. Ongoing research from Michigan State University will help improve understanding of winter mortality.

Coordinated outreach from local, state, federal and international agencies should substantially improve prevention, detection and treatment of hemlock woolly adelgid. This provides time to refine long-term, integrated management tactics. Statewide outreach and education on hemlock woolly adelgid continue. For more information, visit Michigan.gov/HWA.

Larch casebearer and eastern larch beetle - *Coleophora laricella* and *Dendroctonus simplex*

Larch casebearer was introduced to the United States from Europe, causing periodic outbreaks that defoliate Michigan tamarack. Relatively low larch casebearer populations in recent decades have been attributed in part to introduced parasitoids (biological control agents). However, recent research in Minnesota suggests that warmer autumn temperatures may be suppressing the beneficial parasitoids and favoring larch casebearer survival. In spring 2020, defoliation was observed in the eastern Upper Peninsula. Affected trees appear yellow to brown, especially at needle tips.

Larch casebearers are easy to miss, and damage could be confused with injury from late frost events. Close observation of casebearer-affected needles will show small cylindrical objects attached to needles and hollowed-out needles the caterpillars use as protective cases while feeding in the spring. Pupation occurs during the summer, and affected trees grow new needles. Repeated defoliation- or defoliation in combination with other stressors such as drought or extended flooding - leaves trees more vulnerable to attack by the eastern larch beetle, a native beetle that tunnels under tamarack bark, girdling and killing trees. Studies in Minnesota also suggest warmer temperatures and extended growing seasons may increase eastern larch beetle populations, further contributing to tamarack damage.

The most recent outbreak of eastern larch beetle has been killing Michigan tamarack for several years, with recent reports of damage primarily from the north central and western U.P. Signs of a new infestation include resin flow on the bark during the summer months and yellowing foliage at the bottom of the tree in mid- to late summer. Tops of affected trees may remain green into the fall prior to fall color, then fail to leaf out in the spring. Trees killed by the larch beetle may have loose bark that can be peeled off to display beetle tunnels underneath. These trees can also be identified by woodpecker damage; woodpeckers often remove the bark as they feed on beetles.

Management guidance is to harvest mature tamarack when rotation age has been attained, and to pre-salvage tamarack stands if edge trees show signs of beetle activity. Once eastern larch beetles begin feeding in a tamarack stand, they quickly move through it. Pre-emptive action is required if trees are to be useful for fiber or lumber. Eastern larch beetles also build populations in wind-thrown trees, log piles, snow breakage and logging debris. Removing wood susceptible to infestation helps reduce beetle numbers.



Eastern Larch Beetle damage includes yellow foliage.

Mountain pine beetle - *Dendroctonus ponderosae*

Mountain pine beetle is a major pest of pine trees in western North America, where outbreaks are occurring with increasing frequency and severity. Mountain pine beetle has expanded its range northward and eastward in the last decade, killing millions of pine trees. This expansion is attributed in part to warmer winters, which allow more beetles to survive.

Mountain pine beetles affect pine trees by laying eggs under the bark and introducing a blue stain fungus. The joint action of larval feeding and fungal colonization kills the host tree within a few weeks of attack. As beetle populations increase or trees become stressed due to drought, the beetle population can quickly increase and spread.

Outbreaks have created large amounts of standing dead timber, some of which is salvaged through harvest. The harvested pine has the potential to be shipped to locations here in the Midwest. There are at least two documented incidents of logs killed by mountain pine beetles arriving in nearby Minnesota.

MDARD implemented an exterior mountain pine beetle quarantine in September 2020 to protect Michigan's pine resources. If mountain pine beetle were to become established in Michigan, it would cause severe losses across multiple industries, including timber products, nursery stock and tourism. It could also threaten the recovery of the Kirtland's Warbler, a songbird recently removed from the federal endangered species list. The DNR estimates the value of pine sawtimber alone for Michigan's native pines is over \$3 billion.

Michigan has three native species of pine: white pine, jack pine and red pine. Other pines widely grown include Austrian pine and Scots pine. Although most pine species are at risk, jack pine is among the most susceptible.

The Michigan mountain pine beetle quarantine, along with similar quarantines in Minnesota and Wisconsin, assures regional uniformity in keeping this pest out of the Great Lakes region. The quarantine regulates movement of pine logs, stumps, branches and other forest products with bark attached, including lumber and firewood. The quarantine regulates pine from infested states (Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington and Wyoming) and Canadian provinces (Alberta, British Columbia and Saskatchewan).

Exemptions to the quarantine include cut Christmas trees, nursery stock, pine bark mulch, processed lumber that has been kiln-dried, lumber and posts treated with wood preservatives and lumber and posts that are 100% bark-free.

Spotted lanternfly - *Lycorma delicatula*



*Immature spotted lanternfly.
Image courtesy of University of Pennsylvania.*

Spotted lanternfly continues to be the focus of discussion when evaluating new invasive species expected to show up in Michigan. To date, no established populations of spotted lanternfly have been discovered in Michigan. However, in two separate incidents, three dead spotted lanternfly adults were found in the state. In mid-October, a single dead adult was found in mid-Michigan on a shipment of nursery stock from Pennsylvania. In early November, two dead adults were found on a shipment of building supplies in southeast Michigan. MDARD and USDA's Animal Plant Health Inspection Services, Plant Protection and Quarantine Program conducted follow-up investigations and found no other evidence of

spotted lanternfly in the state.

Spotted lanternflies pass through four larval stages before reaching the adult life stage. In the first three life stages, the insects look like small black beetles with white spots. In the fourth stage, they change in appearance, turning red with black and white patterning. 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. When first laid, egg masses look like fresh putty or chewing gum. As egg masses age, they crack and begin to look like dried mortar. The color of egg masses varies from light tan to dark gray-brown. Each egg mass can contain 30 to 50 eggs.

The list of hosts the spotted lanternfly can feed on seems to be ever-growing. Among our native trees, black walnut, oak, willow, maple and sycamore are at risk, as well as Michigan's fruit and nursery crops such as grapes and hops. 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 that grows on it can foul surfaces and kill surrounding plants. Feeding can leave host plants weakened and susceptible to secondary infection.



Adult spotted lanternflies lay brownish egg masses on tree bark.

Both recent incidents illustrate how easy it is for this species to move about. It seems like it is only a matter of time before an established population is found here in Michigan. MDARD is working with federal, state and local partners to develop response plans and communication strategies to ensure the state is ready when the pest arrives.

Spruce budworm - *Choristoneura fumiferana*

Observations in 2020 suggest a second year of increasing defoliation from spruce budworms, affecting spruce and fir trees across the Upper Peninsula. Over the past decade, we have documented widespread infestations of this native insect, particularly in the western U.P. However, populations have fluctuated from year to year, with little defoliation observed in 2018.

Due to pandemic-related restrictions, 2020 aerial surveys to map defoliation were limited to the Hiawatha National Forest. The extent of damage is represented in the areas mapped, but some areas of the national forest were unable to be mapped. Based on reports, defoliation was greatest in areas of the central to western U.P., including Delta, Marquette and Menominee counties.

In some locations with exceptionally heavy spruce and fir defoliation, hemlock defoliation also was reported. In other areas, heavy defoliation in recent years meant limited host trees were available this year. In the eastern U.P., defoliation was patchy, with extensive defoliation in the Cedarville area of Mackinac County. In the Lower Peninsula, more scattered spruce and fir stands are less likely to sustain large budworm outbreaks, and little defoliation was reported.

We anticipate the current outbreak will follow historical patterns, where extensive defoliation and tree deaths occur across the northeastern United States and Canada every 30 to 40 years, with outbreaks generally lasting 10 to 15 years. In the western U.P., we began documenting widespread infestations of spruce budworm in 2010. In some areas, there may not be a lot of vulnerable host trees left. In other areas, particularly farther east, we may see continued defoliation for several years. We anticipate localized defoliation may continue as long as vulnerable mature and overmature balsam-fir stands remain. Infested stands often lose 60-80% of fir trees and 20-40% of spruces.

Recommendations for management are to harvest spruce and fir trees when they reach 50 years old and to salvage stands with significant budworm damage. If the spruce or balsam trees are dying, it is important to cut them and get the timber to a mill within one year to retain value.



Spruce trees appear patchy and thin where spruce budworms defoliate them by feeding on needles.

Diseases

Beech leaf disease – *watchlist update*

Michigan's beech trees have been decimated by beech bark disease in many areas. Unfortunately, there is another threat to beeches on the horizon. Although not yet detected in Michigan, as of fall 2020 beech leaf disease has infected American beech trees in northeast Ohio, northwest Pennsylvania, New York, Connecticut, Rhode Island, Massachusetts and New Jersey and in southern Ontario within 15 miles of Detroit. The disease damages trees' buds and leaves, leading to loss of vigor and, in areas with the longest history of the disease, death. Concerningly, beech bark disease-resistant American and European beech trees also have displayed symptoms. Research in Ohio and Ontario suggests it is caused by a microscopic worm called a nematode (*Litylenchus crenatae*), although investigation of other associated microorganisms is ongoing.

The DNR, along with Michigan State University researchers, are collaborating on survey efforts. The focus is southeast Michigan, which is closest to the detections in Ohio and Ontario, as well as other locations where recently planted beech trees potentially could have been exposed to infected trees in other states.



Early signs of beech leaf disease can include leathery, pucker or dark leaves. R. Lidster OMNRF

Little is known about how beech leaf disease spreads, how trees become infected or how long it takes for symptoms to develop. American, European and Asian beech varieties have all developed symptoms. Symptoms appear to become more severe from one year to the next and trees near infected trees appear likely to develop symptoms over time. Nematodes are known to be transmitted by insects and birds, and in water films on plant surfaces, which may create a path for the disease to spread.

Initial symptoms of beech leaf disease are dark, slightly thickened bands between leaf veins. As symptoms progress, the leaves become more distorted and pucker. Eventually, the entire tree canopy may have sparse foliage with small, chlorotic (yellow) or dark, leathery, pucker or swollen leaves.

If you suspect you have observed symptoms of beech leaf disease in Michigan, consult the following website: <https://bygl.osu.edu/node/885> to help rule out other possibilities, then take photos, record the location, and call 1-800-292-3939 or email MDA-Info@Michigan.gov.

Heterobasidion root disease

A fungal disease attacking conifers was first reported in southern Michigan in 1963. It has had several name changes since its discovery: annosum, annosus, Fomes root rot and now Heterobasidion root disease. Although thought to be native, Heterobasidion root disease has not been detected throughout the whole state.

Red, white and jack pine in actively managed plantations are especially vulnerable to infection, although most recent detections have occurred in red pine plantations. Heterobasidion root disease is most easily detected in the fall when the fungi's "fruiting bodies," or mushrooms, are more obvious at the base of affected trees and stumps.



Forest health staff surveying for disease.

Ongoing survey activities have confirmed its presence in 19 Lower Peninsula counties and two eastern Upper Peninsula counties. In 2020, detections occurred in Emmet and Mackinac counties for the first time, north of most previous detections. Additional detections were made in counties with previous confirmations. Many new detections occur when pockets of dead red pine are identified during aerial survey activities, or from reports by local field foresters. The Forest Health Response Team's investigation of a report in Emmet County in late October led to the discovery of a significant area of infection spreading across nearly 50 square miles. Nineteen new stands and just under 600 acres have been found to be infected in Emmet County. Several of these plantations were being prepared for timber sales at the time of discovery. These sales and prescriptions must be modified to address the presence of the disease and risk of further infection. Surveys will resume in the spring.

Infections occur when fungal spores land on freshly cut stumps. Once the stump is infected, the fungus slowly grows through roots that are connected among trees that grow close to one another. Eventually, a pocket of dead trees develops. Once introduced, Heterobasidion root disease is difficult to eliminate and is a threat to future conifer crops on that site. As the amount of infection at a site increases, more fungus forms, more spores are present and the risk of infection in nearby areas increases.

The DNR took a risk-based approach in developing an advisory to protect Michigan's red pines. Currently, on state-owned land, an "advisory zone" of 5 miles around known infection sites is considered at increased risk for infection. DNR forest health staff assess all red pine plantations scheduled to be harvested within the zone. If, following intensified surveys in and around the plantation, the risk of Heterobasidion root disease infection is determined to be high, restrictions are placed on the sale. Restrictions for state land sales include winter logging from Jan. 1 to March 31 or using stump treatment to prevent infection.

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. When stump treatment is required, one of two products (Cellu-Treat or RotStop C) must be applied to stumps after cutting.

An interactive, online Heterobasidion root disease map shows current confirmed locations of the fungus in Michigan and the five-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 click on “[View and report Heterobasidion root disease locations.](#)” Reporting potential Heterobasidion root disease helps protect our forests for future generations.

Oak wilt – new approaches



DNR staffers trial a new oak wilt treatment.

Oak wilt, an invasive fungal disease, was first identified in 1944. The effects of this disease in Michigan began to become apparent during the 1980s. Today, oak wilt continues to spread and kill thousands of oaks in forests, woodlots and residential landscapes, directly impacting ecosystems and property values. As Michigan has lost other tree species such as ash, beech and elm to invasive pests, oak becomes increasingly important.

Red oak species are especially vulnerable to oak wilt and may die within weeks of infection. The fungus spreads into the roots, where it eventually moves to nearby trees through connected root systems. When untreated, groups of red oak trees can die within a few years. This creates an oak wilt “epicenter,” or pocket of dead and infected trees. New locations can get infected under the right conditions: the time of year, ample insect vectors, viable spores and a physical tree wound. Oak wilt’s high-risk period occurs from April 15 to July 15, when insects that move spores from infected trees to fresh wounds on oaks are most active. It is important to refrain from pruning or otherwise wounding

oaks during this high-risk period to reduce the chance of starting new infections.

Trees, logs and firewood from oak wilt-killed trees produce infectious spores the following year. When firewood from infected trees is moved to new areas, oak wilt can spread with devastating impacts. Oak trees killed from oak wilt more than two years ago can no longer spread oak wilt or produce spores.

Unlike other invasive pests like Dutch elm disease, beech bark disease and emerald ash borer, when oak wilt infections are detected and treated, we can protect many oak trees that would otherwise be killed. Over the past several years, the DNR has used vibratory plows to sever tree roots and prevent the spread of the disease from infected to healthy trees. While the technique has been effective, it does not work in rocky ground, on steep hillsides or in residential areas with buried utility lines. This year, we tested a new technique using herbicides as an economical substitute treatment. It has been promising in trials elsewhere and can be used where trenching is not possible.

The herbicide treatment relies on killing oak root systems before the fungus can invade and spread to adjacent trees. Healthy oak trees surrounding an epicenter are girdled by making two cuts near the tree base, through the bark and into the wood. Triclopyr herbicide is applied to the girdle. Alternatively, trees are cut and the herbicide is applied to the cut stump surface. Research suggests it may take multiple years for the root systems to die and consequently, the technique is being used on a limited basis at a few sites until we have more data on efficacy. We do not currently recommend the technique for widespread use.

Oak wilt is widespread in the southern Lower Peninsula, with spotty distribution in the northern Lower Peninsula. In the western Upper Peninsula, oak wilt is common along the border with Wisconsin from Iron County south. See the interactive [online oak wilt map](#) created by the DNR for confirmed and suspected locations. Data on treatments performed by the state is also provided, information about treatments on private property is limited and does not reflect the entire extent of treatments being conducted on private land. Visit Michigan.gov/ForestHealth and click on “[View and report oak wilt locations](#).”



A DNR forest health specialist treats an oak stump with herbicide to prevent oak wilt transmission.

Need help? A variety of programs address the threat of oak wilt on private land.

- MDARD’s Forestry Assistance Program uses foresters associated with county conservation districts to provide some assistance to private landowners through oak wilt outreach, confirmation and treatment; learn [who to contact in your area](#).
- The DNR’s Forest Health Program provides oak wilt advice and can be contacted by emailing DNR-FRD-Forest-Health@Michigan.gov.
- [MSU Extension](#) can also provide valuable insight on oak wilt.
- Private arborists offer fee-based oak wilt assistance. For a list of oak wilt-trained arborists, see MichiganOakWilt.org/oak-wilt-qualified-vendor-directory.

Invasive plants

Mile-a-minute weed - *Persicaria perfoliata*

The Michigan DNR and MDARD confirmed the presence of a new invasive plant, mile-a-minute weed, at Albion College's Whitehouse Nature Center in Calhoun County.

Mile-a-minute weed, a fast-growing, barbed vine native to India, Asia and the Philippines, was not known to be in Michigan until Doug White, professor of ecology at Albion College, discovered it in October while surveying for house wrens.

"I'm not normally out there in October, but we color-banded nestlings this year, and I was following the fledglings," said White. "I saw these purple and blue fruits on a plant, and I was curious. Years ago, I wrote my dissertation on bird-dispersed fruits, so naturally I wanted to find out what they were."

White took photos, plucked a branch from the vine and, after some research, determined that this was an invasive plant previously unknown in the state.

A species is considered invasive if it is not native and can cause harm to the environment or economy.



Blue fruit grows in spikes above a circular, clasping leaf. Photo from Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

The vine's fast growth and climbing habit allows it to overtake native and landscape vegetation, eventually smothering plants and trees under dense, prickly thickets. Because of the risk to Michigan's Christmas tree farms, reforestation projects and habitat restoration areas and the plant's limited distribution, mile-a-minute weed is on the state's invasive species watch list.



Mile-a-minute weed is a vine identified by triangular leaves and spikes of blue, pea-sized fruit. Photo from Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Mile-a-minute weed is an annual vine that gets its name from its ability to grow up to six inches per day, or 25 feet in six to eight weeks. Its light green leaves are shaped like equilateral triangles, and both the stems and leaf blades are lined with small, recurved barbs that help it climb over other vegetation. Small, inconspicuous white flowers appear in spring, developing into spikes of pea-sized, blue fruits in mid-summer. Unusual circular leaves clasp the stems below the fruits.

Mile-a-minute weed thrives in full sun and wet soils, but it can grow in a variety of conditions. Like many invasive plants, it takes advantage of open space and disturbed areas including roadsides, stream banks, forest edges and fence lines.

The first established population of mile-a-minute weed was found in a Pennsylvania nursery in the 1930s, likely brought to the location in contaminated nursery stock. Because the fruit is attractive to birds, deer and small mammals, seeds are easily spread miles away from the original plants. Mile-a-minute weed infestations have been reported in 15 states across the United States. The closest known infestation is in northern Ohio.

DNR and MDARD staff members are working with regional partners, including Cooperative Invasive Species Management Areas, Albion College faculty and staff and other landowners to determine the distribution and extent of the infestation.

The infestation at the Whitehouse Nature Center will be managed by Albion staff and students, who will remove the vines. BCK CISMA, serving Barry, Calhoun and Kalamazoo counties, along with JLW CISMA in neighboring Jackson, Lenawee and Washtenaw counties, will assist with other potential sightings.

Though mile-a-minute weed can be removed by hand, seeds can persist in the soil for up to six years, so infested sites need to be monitored regularly for regrowth. New shoots can be mowed or tilled in the spring or early summer before fruiting, as even immature green fruits can carry viable seeds and create new plants.

Though most vegetation is now dying back, mile-a-minute weed fruits may still be visible on the vine, and barbs will be present on stems and leaf blades. Anyone encountering a vine that could be mile-a-minute weed should visit Michigan.gov/Invasives to review identification information. If the plant appears to be mile-a-minute weed, take photos, note the location and report the find using one of these methods:



Recurved barbs line mile-a-minute weed vines and leaf margins. Photo from Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

- Use the Midwest Invasive Species Information Network online reporting tool.
- Download the MISIN smartphone app and report from your phone - MISIN.MSU.edu/Tools/Apps/#home.
- Contact [Susannah lott](mailto:Susannah.lott@mdard.org), 517-420-0473, MDARD Pesticide and Plant Pest Management Division.

Wild parsnip and giant hogweed – two dangerous plants to watch for

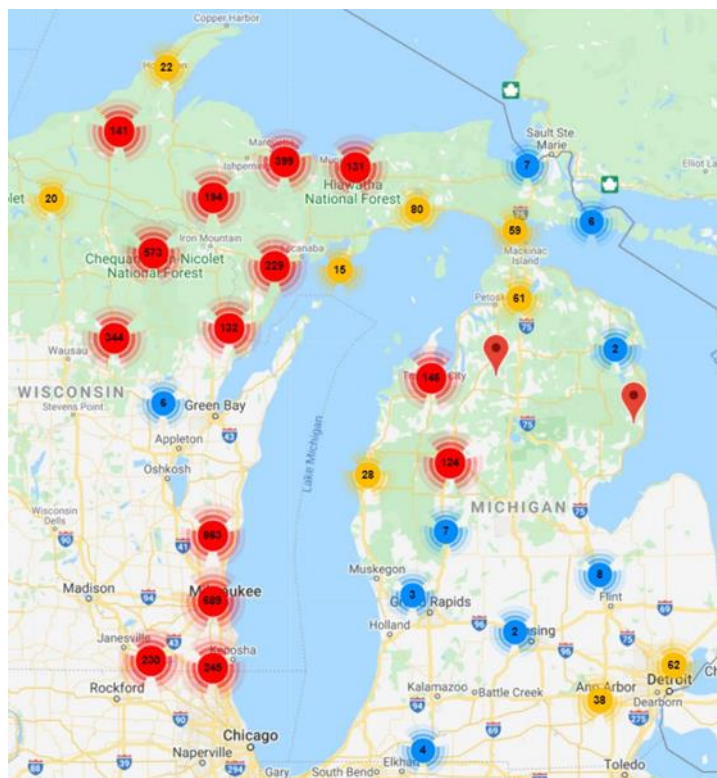
Anyone who has worked on invasive plant issues for long will likely recognize two species notorious for their human health implications. “Phytophotodermatitis” is the technical term for the severe skin burns and blistering that can result from being exposed to giant hogweed or wild parsnip plants. These species are being highlighted because they have re-emerged as priority issues due to successful management progress of giant hogweed, but increasing spread in the case of wild parsnip.

Giant hogweed (*Heracleum mantegazzianum*)

Toward the end of 2018, DNR and Cooperative Invasive Species Management Area staff investigated and confirmed 53 sites with giant hogweed in Michigan. An older database previously maintained by MDARD was used to help guide the investigations, update the status of infestations and connect them to management projects led by local CISMAs. CISMAs have begun to implement adaptive management practices to bring 100% of known hogweed populations under management. The Western Peninsula Invasives Coalition, covering Gogebic, Iron and Baraga counties, and the Southern Michigan Invasive Species Team, covering Hillsdale, Branch and Saint Joseph counties, will be critical to this effort. One of the biggest challenges with giant hogweed is that it is commonly mistaken for look-a-like species. Many other plants, including cow parsnip (most commonly), wild parsnip and angelica and Queen Anne's lace are often misidentified as giant hogweed. Take the time to [review similar plants](#) before reporting giant hogweed.

Wild Parsnip (*Pastinaca sativa*)

Wild parsnip is an issue of increasing concern across Michigan's Upper Peninsula. Although wild parsnip has been in Michigan since the 1800s, it has spread rapidly along roadsides and trails over the past five years. Because it causes burns and blisters like its cousin, giant hogweed, it represents a potential public health concern if populations are near high-foot traffic areas. There are currently 1,776 mapped locations of wild parsnip across Michigan, of which more than 1,200 are located in the U.P. Wild parsnip has relatively low density through most of the northeastern and Midwest states, with pockets of higher density in Minnesota, Wisconsin and Michigan's Upper Peninsula. CISMAs have led the mapping effort in Michigan and have removed infestations in several high priority locations. However, the extent of the spread is too great for CISMA field crews to have long-term impacts at a landscape scale. The solution to the wild parsnip problem will require new strategies and effective planning. The timing of right-of-way mowing seems to be a sustainable long-term solution, but more understanding is needed. The Michigan Department of Transportation is conducting experiments to identify new strategies for reduction through timed mowing. Awareness and coordination between groups working to address wild parsnip is a recognized need and CISMAs have been at the forefront of this effort.



Wild Parsnip is spreading across Michigan's Upper Peninsula and northern Lower Peninsula, indicated by red markers.

Research and monitoring

Propagating lingering, resistant ash trees for reintroduction



Resistant ash tree saplings ready for transport.

Invasive species have been a serious issue for Michigan's forests over the last century, and now there are more pathways than ever to introduce new ones. Many of these pests and diseases can cause substantial damage to our forests and have the potential to wipe out tree species or even whole groups of trees. Emerald ash borer, on its own, has the potential to remove ash from our forest types statewide.

Emerald ash borer was discovered in 2002 near Detroit after it was shipped across the ocean from its native landscape in Asia on solid wood pallets. After identifying when the infestation began, we now know that the emerald ash borer had been in Michigan since the mid-1990s. The insect has flourished in Michigan, invading all five native species of ash with different levels of impact. Pumpkin ash, formerly found in southeast Michigan at the northern edge of its range, has been eliminated from the state by emerald ash borer. Green and black ash have seen the greatest impacts statewide. These species are

highly susceptible to attack. This results in high emerald ash borer populations, which can overwhelm plant defenses. White ash is somewhat tolerant of emerald ash borer at low densities, but because of these high populations it has also experienced widespread mortality. The fifth species, blue ash, occurs naturally only in southern Michigan, but is resistant to high emerald ash borer pressure and has survived without the devastation observed in the other species.

After discovery, a quarantine was immediately put in place to help slow the insect's spread. However, public awareness was low, and the known extent of the infestation was drastically underestimated. The emerald ash borer is a great flyer and can get around well on its own, but it spread like wildfire through firewood as people cut down dead ash trees and moved the disease along with the wood throughout most of the state. By 2018, emerald ash borer had spread throughout the majority of Michigan, and the statewide internal quarantine was repealed. Three counties in the western Upper Peninsula have not reported emerald ash borer, although undetected emerald ash borer populations may be present.

To date, the state has lost hundreds of millions of ash trees, which were a common component in most forested settings. Today, in many areas of the state, you can find standing dead ash trees that are remnants of emerald ash borer attack. In this gloom left behind, surviving ash trees have emerged. Most of the green ash were too young to be attacked when the initial wave of emerald ash borer moved

through the stand. A few were attacked but survived. These green ash trees were termed “lingering ash.”

Over the last few decades, USDA Forest Service scientists, with assistance from Michigan and other states, have been evaluating why lingering ash survived where so many others did not. They have determined that a few green ash have a natural, partial resistance to emerald ash borer. These resistant ash trees have been sampled, propagated and grown in seed orchards to further evaluate seedlings. When these partially resistant trees are crossed, one-quarter of seedlings are less resistant to emerald ash borer, one quarter are more resistant, and half of the seedlings are as resistant as their parent trees. Eventually, highly resistant ash trees can be used in efforts to return ash to Michigan forests.

In 2020, Michigan received its first shipment of resistant ash seedlings to establish a seed orchard that would be used solely to help restore ash trees throughout Michigan. The saplings are crossed from lingering ash found in the region. The DNR’s Happy Little Trees Program, supported by the Bob Ross Foundation, was able to help move these saplings from the research station in Ohio back to Michigan before they were lost due to the effects of the COVID-19 pandemic. Hundreds of thousands of dollars would have been lost if the trees were not moved in time and it would have set back progress by roughly five years.

Once the 250 ash trees arrived in Michigan, the DNR and MSU helped maintain and plant the trees into the new seed orchard near Brighton. These trees will need several years to grow, but in time will start producing resistant ash seeds that will be key to restoration efforts across the region.

Michigan State University – McCullough Lab

Black ash conditions at varying stages of the emerald ash borer invasion – *Patrick Engelken, Austin Wujkowski, Deborah McCullough*

Since its discovery in 2002, emerald ash borer has become the most destructive and costly forest insect to ever invade North America. Currently, 35 states and five Canadian provinces have EAB infestations. Michigan has the longest history with emerald ash borer, and evaluating conditions in post-invasion forests will provide essential information for other regions facing emerald ash borer impacts.

This summer, we continued to evaluate current conditions in post-invasion forests where black ash (*Fraxinus nigra*) was originally a major overstory component.

Black ash is the most highly preferred and vulnerable host in North America for the emerald ash borer. This species is most often found in swampy or boggy sites, including riparian forests along rivers, streams and lakes. While its timber value is minimal, the ecological role of black ash trees in



A post-invasion forest where black ash trees have been killed.

these systems is substantial. Black ash also is an important cultural resource for many Native American tribes in Michigan and the northeastern United States and First Nation tribes in eastern Canada.

We recorded size, density and condition (live, dead) of black ash and other overstory trees, density and species of regeneration (recruits, saplings, seedlings, stump sprouts) and coarse woody debris. Virtually all overstory black ash were dead in the sites we examined, which raises doubts about the persistence of this unique species. On a positive note, healthy black ash saplings and seedlings were often abundant. Whether these young trees will survive and mature remains unknown.

We are collaborating with the USDA Forest Service and USDA APHIS scientists in other states who are collecting similar data in black ash areas where ash borer densities are peaking and in sites where the insect has not yet had an impact. Collectively, results from this project will provide critical information about restoration of affected sites, along with the future of black ash and its prospects for co-existing with emerald ash borer.

Recovery of hemlock trees following hemlock woolly adelgid infestation **Justin Keyzer, Deborah McCullough, MSU**

We continued to evaluate hemlock trees treated with systemic insecticides for control of hemlock woolly adelgid in 2016 or in 2018.

While trees had deteriorated substantially between fall 2017 and December 2018, improvement was noted in 2019. Canopy condition of most trees treated with an insecticide showed considerable improvement in 2020 as current-year needles expanded. Untreated control trees and trees treated with slow-release tablet formulation of imidacloprid, however, remained in poor condition.



Justin Keyzer of MSU prepares to rate chlorophyll inflorescence, a measure of how well needles photosynthesize, on a hemlock shoot.

In addition to periodically evaluating canopy condition, we are measuring the amount of exposure to sunlight each tree receives. Photosynthesis rates are also being quantified during the summer and winter, corresponding to feeding activity of the progrediens (overwintering and hatching in spring) and sistens (hatching in summer) generations, respectively.

We are currently collecting and processing shoots from upper and lower canopies of trees treated with systemic insecticides in 2016 or 2018 for analysis of foliar insecticide residues, in cooperation with collaborators at the USDA APHIS Plant Protection and Quarantine laboratory in

Massachusetts. Results will indicate how long we can expect trees to be effectively protected from HWA and when retreatment will be necessary. Results will be shared with personnel from Michigan's DNR, MDARD, the USDA Forest Service and other groups involved in the hemlock woolly adelgid program in Michigan.

Early detection of targeted non-native forest insect pests in Michigan

Paige Payter, Deborah McCullough, MSU

In 2020, we surveyed 45 locations across Michigan to detect potentially damaging non-native forest insect species. Early detection of a new invasive forest pest is an essential aspect of protecting the health of Michigan forests.

Most species targeted by this survey are not known to be established in the United States or at least are not in Michigan. Forest pests of concern include insects such as beetles and horntails that feed on wood or phloem (inner bark), along with selected defoliators. This includes several moths that feed on leaves of hardwood trees or needles of conifer trees as larvae (caterpillars) in Asia, Russia or Europe. Our



Funnel traps are used to capture bark beetles and other wood-boring insects.

project is a collaboration among Michigan's DNR and MDARD and the USDA Animal and Plant Health Inspection Service.

At each site, we set up an array of traps in places such as forest campgrounds and parks where firewood might be introduced, sawmill, and industrial sites where pallets or wood crating may arrive with imported materials. Each trap was baited with pheromones or volatile compounds produced by host trees of the insect pests targeted by the survey. We checked traps at monthly intervals to replace lures and collect captured insects.

Insects were returned to the MSU campus and sorted into groups. Identification, a labor-intensive process, is under way. In 2020, for example, more than 6,000 longhorned beetles, metallic woodboring beetles and horntails were captured in the 600 traps we monitored. An important benefit of this project is the information we acquire about the distribution, diversity and activity of native wood-boring insects, many of which have not been well-studied.

Activity and contamination of sap feeding nitidulid beetles in oak wilt infection centers

Olivia Morris, Deborah G. McCullough with Karandeep Chahal, Monique Sakalidis, MSU

We monitored activity of several species of sap beetles in active oak wilt infection centers in red oak stands in northern Michigan from April through October in 2018 and 2019.

Beetles captured in baited traps were collected every two weeks and identified as to species. A subset of beetles was tested in the laboratory to determine if individuals were carrying spores of the oak wilt fungus. In 2018, we captured 1,188 beetles representing 21 species in 18 traps set up in three sites. Beetle activity was highest during a four-week period from early May to early June, when almost 60% of all beetles were captured.

A total of 330 captured beetles were evaluated in the lab to determine if they were carrying oak wilt spores. Overall, 17.6% of the tested beetles, or 4.9% of all captured beetles, were bearing viable spores

and all contaminated beetles were captured in May or early June. Spring weather in 2019 was generally cooler and wetter than in 2018, which perhaps delayed and extended nitidulid beetle activity in the growing season.

In 2019, we captured 735 nitidulids representing 18 species in 16 traps monitored in four sites. Beetle activity was highest over a six-week period between early May and mid-June in 2019, when 65% of all nitidulids were captured. As part of a related study, forest pathologists inoculated numerous trees in the study sites with the oak wilt fungus in 2018 and 2019. Not surprisingly, many of these inoculated trees produced mycelial mats, a term for fungal colonies, in 2019. Contamination rates of beetles were roughly three times higher in 2019 than in 2018. Nearly all (95%) of the contaminated beetles were captured between mid-May and mid-June in 2019, but three contaminated beetles were captured in August. Beetle contamination in late summer, along with the overall higher contamination rates, reflect the abundance of mycelial mats on the inoculated trees in 2019.



Olivia Morris, MSU, checks a sap beetle trap in an infection center.

Michigan State University – Sakalidis Lab

Oak wilt research from the Forest Pathology Lab at Michigan State University Karandeep Chahal, Monique L. Sakalidis, MSU

To determine when red oak trees are not susceptible to oak wilt, we conducted monthly inoculations by injecting a large number of spores produced by the oak wilt fungus, *Bretziella fagacearum*, into red oak trees at three research sites in the Lower Peninsula. The work took place from August to October 2017, April to November 2018, March to November 2019 and in mid-March 2020.

We monitored these trees biweekly from March to November and recorded development of symptoms and tree mortality. We found that trees inoculated mid-March to late September died, indicating that they are susceptible to infection during this time period. Trees inoculated in October and November remain alive and have not become symptomatic.

A common symptom of oak wilt is brown, streaky discoloration of the sapwood beneath the bark.

We found that trees inoculated in the spring and summer die rapidly within the current calendar year, while those inoculated in the fall prior to October take longer to succumb to infection and die the following year.



Healthy sapwood is pictured in the top branch. Streaked, diseased sapwood is evident in the middle and bottom photo.

To determine when viable spores of *B. fagacearum* are produced throughout the year, diseased red oaks were inspected for the presence of mycelial mats at 12 field sites twice a month from April to November 2019 and March to November 2020. We observed mycelial mats on wilted red oaks from late April through mid-November; the majority of the mats were observed in May and June. To determine if the spores were viable, or able to germinate and grow, we removed three small disks from the mats and transferred diluted amounts onto agar plates. We monitored the spores for germination and mycelial growth. We found that spores germinated and grew from mats collected from April 24 through November 2019, except for the month of July. As fungi typically need freely available moisture to reproduce, it is possible that hot, dry weather limits mat production. In 2020, viable spores were sampled from mats collected in May to November. No mycelial mats were observed in March or April 2020.

Our results indicate that trees are susceptible to infection from mid-March through late September and that mats and viable spores are produced from late April into November, with a peak in May and June. The peak periods of mycelial mat production and spore viability overlapped with the peak periods of contaminated nitidulid beetle activity (Morris, O & McCullough, D.G.), indicating that the high-risk period for overland spread of oak wilt is in May and June.



Symptomatic leaves turn bronze and appear water-soaked and wilted. “Classic” foliar symptoms of oak wilt include well-defined tanning of leaf tips that move toward the midrib and base of leaves. Later, leaves turn yellow/brown and curl around the midrib.

Since three contaminated beetles were observed in August 2019 (Morris, O & McCullough, D.G.), in areas where there is a large amount of oak wilt, additional precautions to prevent wounds or to apply tree paint to fresh wounds on high-value, healthy trees may be prudent during the month of August in exceptionally high disease pressure areas.

Brown rot of chestnut

Allie Watson, Carmen M. Medina-Mora, Monique L. Sakalidis, MSU

Michigan is one of the largest producers of chestnuts in the United States, but chestnut growers are feeling the effects of brown rot. The fungus *Gnomoniopsis smithogilvyi* (*G. smithogilvyi*) causes brown rot, a kernel disease affecting the quality of chestnut fruit.

Brown rot causes brown lesions to appear on chestnut fruit that makes affected chestnuts unsellable. It cannot be detected unless nuts are cut open for inspection, thereby destroying the nut and again rendering the nuts unsellable. The disease is present in mature chestnuts at harvest; symptoms will also develop over time during cold storage.

Brown rot has been reported globally in nut production areas, particularly in Europe and Australia, and can result in up to 91% of chestnuts infected. It has been detected annually since 2017 in Michigan. Using nuts sampled in fall 2019 and 2020, we have evaluated the diversity of nut-rotting organisms, particularly *Gnomoniopsis* species, and evaluated the effect of cold storage and host cultivar on disease incidence and severity. We collected nuts from three *Castanea* spp. cultivars: Labor Day (Korean x Japanese), Colossal (European x Japanese) and Benton Harbor (Chinese).

To determine if cold storage affects disease development of brown rot, nuts were harvested from the chestnut orchard at the MSU Clarksville Research Station. A total of 1,620 nuts per cultivar were inoculated with either one of two strains of *G. smithogilvyi*, or an agar control containing no pathogen; 800 nuts of each cultivar were left intact to reflect natural infection rates. Two hundred of the naturally infected nuts were cut open and rated immediately after harvest for symptom presence and severity. A subset of inoculated and naturally infected nuts from each cultivar was rated after two weeks at room

temperature or stored for one or two months at 4 degrees Celcius and then incubated for two weeks at room temperature before they were cut open and rated for symptoms. Cold storage resulted in decreased disease severity and incidence and that Colossal is the most susceptible cultivar to natural and artificial infection of *G. smithogilvyi*.

Future research will continue to evaluate the diversity of nut-rotting organisms and determine the timing of and environmental conditions related to spore production in the field and the infection pathway into the host.

Eastern white pine pests: *Caliciopsis* canker disease

Katherine Minnix, Deborah G. McCullough, Rebecca Harkness, Monique L. Sakalidis, MSU

Eastern white pine (*Pinus strobus*), an iconic forest species and the state tree of Michigan and Maine, is widely distributed in the Great Lakes region and much of the northeastern United States. According to recent USDA Forest Service data, more than 104 million eastern white pines currently grow in Michigan forests.

Reports of declining eastern white pines have been increasing in the Great Lakes and northeastern US for the past decade. There have been anecdotal observations of unusual mortality and branch death of white pine along the Au Sable and Manistee rivers in the north-central Lower Peninsula in Michigan. Mortality and dieback were initially observed primarily in regeneration (saplings, recruits), but reports indicate mature trees are now being affected. Symptomatic trees exhibit lower branch dieback, sunken red cankers on the trunk and branches, and resinosis, an abnormal outflow of resin, on the trunk. These symptoms are characteristic of *Caliciopsis* canker disease, which is caused by the fungal pathogen *Caliciopsis pinea*, and has been affecting eastern white pines in New England and the southern Appalachian Mountains.



Caliciopsis fruiting body visualized at 80x magnification. Photo by Rebecca Harkness.

In 2018 and 2019, researchers from Michigan State University surveyed eastern white pine stands in the eastern Upper Peninsula and the northern Lower Peninsula to determine the distribution of *Caliciopsis*, identify site factors that may predicate disease and collect more samples to help us characterize the fungal pathogen causing the disease. *Caliciopsis* fruiting bodies (ascocarps) were found in 21 out of 28 surveyed counties. The presence of the fruiting bodies was not always accompanied by symptoms typical of *Caliciopsis* canker disease. Multiple species of *Caliciopsis* are present in Michigan, including *C. pinea*.

In Michigan, the presence of *Caliciopsis* appears to be associated with high densities of eastern white pine, especially on stressed sites. Further analysis of the survey data may reveal more site- and stand-level factors that predicate this disease. Continuing research at MSU is focused on evaluating the risk *Caliciopsis* spp. pose to different coniferous hosts, characterizing the new species found here in Michigan, determining the distribution of *Caliciopsis* in Wisconsin and Minnesota and determining when

Caliciopsis is producing spores throughout the year. This information will be used to help inform management decisions.

Michigan Technological University – Bal Lab

Beech bark disease research update

Ande Meyers, Tara Bal, MTU



Technicians excavating non-resistant American beech seedlings from the Hiawatha National Forest.

A grafting program to combat beech bark disease (BBD) in Michigan National Lakeshores was established in 2017. In grafting, a scion, or leaf-producing shoot, from a BBD-resistant American beech is joined to a non-resistant rootstock, creating a small clone of the parent tree. A single large branch from a resistant tree can yield enough scions to create many grafted trees, but each rootstock is used to create only one grafted tree. With multiple agencies pursuing grafting, a shortage of commercially available seedlings has led to a bottleneck in availability. To combat this shortage, personnel at Michigan Technological University have been exploring alternate routes of sourcing rootstocks for grafting.

A professional partnership was formed in 2019 with the USDA Forest Service's Oconto River Seed Orchard in Oconto, Wisconsin. Scott Rogers, Forest Service orchard manager at Oconto, trained personnel in American beech seedling care and grafting, and donated extra rootstock to the Michigan Tech grafting program in an ongoing resource-sharing

agreement. In return, resistant scions from national park properties were shared to expand the genetic diversity of resistant Michigan trees in the Oconto American beech seed orchard.

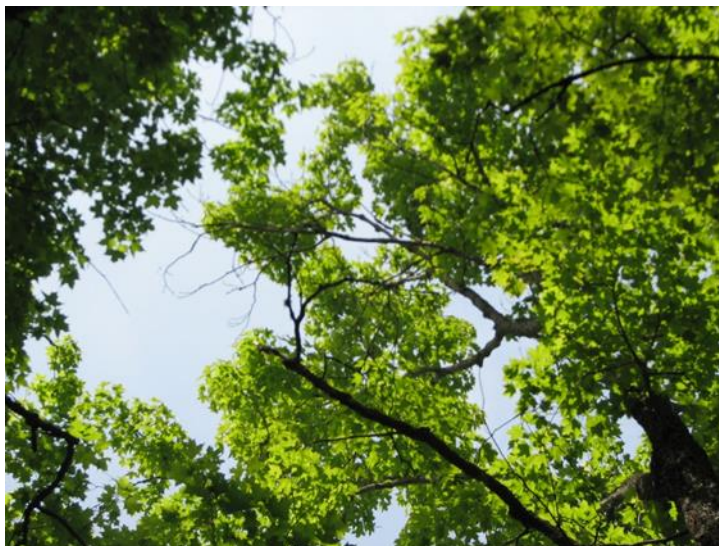
Non-resistant beech seedlings were excavated from Hiawatha National Forest land in 2018 and 2019 and planted in containers at Michigan Tech. Survival rates of excavated seedlings were significantly higher than commercially purchased bare-root seedlings. Seedling height and root mass were not determined to influence survival.

Research is ongoing to determine any apparent morphological features that will allow easier field selection to increase likelihood of survival of wild seedlings as a more reliable rootstock source in grafting programs.

Maple dieback continues to be reported

Julie Grinstead, MTU

Anecdotal reports of sugar maple (*Acer saccharum*) dieback and decline have continued in the western Upper Great Lakes Region over the last decade. Symptoms appear as crown loss or reduced twigs and foliage and can lead to decline characterized by decreased vigor and growth and a higher death rate. Sugar maples are an iconic species in Michigan, contributing economically to the timber and syrup industries, recreation and tourism. They're also ecologically important as a keystone species.



Maple dieback symptoms include crown loss and reduced foliage.

Previously, episodes of maple dieback were tied to reduced precipitation, defoliation from insects, pathogenic fungi, atmospheric deposition, poor management or all of the above. To delve more deeply into the factors associated with maple dieback, in 2009-2012, researchers at Michigan Tech evaluated sugar maple stands on private and publicly managed forests for causal relationships. Forest floor disturbance due to exotic invasive earthworms was highly correlated with maple dieback, along with decreased thickness of leaf litter, increased soil carbon, decreased soil manganese, and reduced herbaceous cover. All are associated with earthworm activity. However, these factors were highly variable across the landscape.

A follow-up study 10 years later is currently under way to monitor changes in sugar maple dieback in the western Upper Great Lakes region. These surveys will better determine the current extent of maple dieback trends across the landscape, and work to refine and identify additional site factors that may be associated with maple declines such as Lecanium scale insect populations and browsing by animals. During the summer of 2021, researchers plan to revisit original sites and identify new areas of apparent maple dieback and decline. For instance, foresters at the Hiawatha National Forest have already provided us with several new areas recently noted with severe crown loss.

The goal of this research is to aid forest managers in the Upper Great Lakes region to anticipate, prevent, decrease and/or salvage maple trees with dieback in the future. Refining the National Forest Risk Assessment maps will help land managers develop decision-making tools to mitigate risk. This project is funded by the USDA Forest Service in conjunction with Michigan Tech in Houghton.

Action and partnerships

Statewide Forest Action Plan

The DNR's Forest Resources Division, in a collaborative process with stakeholders, recently developed and finalized the creation of a new digital [Landscape Assessment of state forestland and a 10-year Statewide Forest Action Plan](#). The action plan is a strategy that guides management activities to address issues and trends, including sustainable management of Michigan's forest resources in areas including fire management, research, invasive species response, community outreach and other areas. It lays out goals for Michigan's forests and how we can collectively achieve those goals. The 2020 Forest Action Plan addresses some statewide aspects of forest management as well as identifying outreach goals and potential resources for private forest landowners.

State Forest Management Plan

The DNR manages Michigan's nearly 4 million acres of state forests for public use and enjoyment, wildlife habitat, forest health and forest products. Plans guiding forest management activities are developed and published for 10-year periods as required by the Natural Resources and Environmental Protection Act. The DNR is also required to maintain third-party certification that forests are managed using sustainable practices.

The next State Forest Plan, targeted to be finalized in 2021, will replace the [2008 State Forest Management Plan](#) and [three regional state forest management plans](#). This next plan will combine the older plans into a single planning framework that provides for the conservation, sustainable use and management of state forest lands.

Private landowner resources

Well-managed, healthy forests produce clean water, wildlife habitat, recreation opportunities and sustainable forest products. Family forest landowners own 9 million acres or 45% of Michigan's approximately 20 million acres of forest. It is challenging to provide information about forest health to 400,000 diverse landowners, so the DNR and its many partners use a variety of methods to inform family forest landowners and inspire them to be good stewards of their woods.

The [Michigan Forest Stewardship Program](#) connects landowners with private-sector foresters to develop custom forest stewardship plans to help them manage, protect and enjoy their woods. Forest stewardship plans help landowners identify their goals, understand their natural resources, plan future management activities and participate in other programs. All forest stewardship plans are required to include information about present or impending forest health issues including insects, diseases and invasive species. The Forest Stewardship Program, funded by the USDA Forest Service, has been active in Michigan since 1990 and has helped nearly 7,000 landowners become better stewards of 1.1 million acres. Many foresters encourage landowners to actively manage their forest with commercial timber sales to address forest health issues and to maintain vigorous stands that can withstand insects or diseases in the future. Some landowners invest their own time and money on forest health treatments. Forest stewardship plans are accepted by the USDA [Natural Resources Conservation Service](#) when landowners apply for financial assistance to implement conservation practices to address concerns such as forest health issues.

Michigan's [Forestry Assistance Program](#) helps family forest owners become active stewards of their forests and woodlands. MDARD, conservation districts, other state and federal agencies, Michigan State University Extension and private-sector natural resource professionals work together to help family forest owners achieve their goals and get the most from their wooded property. The program consists of 19 conservation district foresters serving 46 counties. Forestry Assistance Program foresters offer no-cost services to family forest owners and do not compete with the private sector. They serve as an initial point of contact for forestry-related natural resource concerns in their community.

[Michigan State University Extension](#) provides forest health information to landowners through articles, workshops and webinars.

The State of Michigan values these public-private partnerships to provide resources, information and experts to help Michigan's family forest landowners maintain and improve the health of their woods.

Contact information and acknowledgements

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