2015 Forest Health Highlights

Michigan Department of Natural Resources

Acknowledgments

Forest Health Highlights is a summary of the condition of Michigan's forests during 2015 and the work done to preserve and protect them by Forest Resources Division, Department of Natural Resources, www.michigan.gov/foresthealth.

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Cover photo: The redheaded pine sawfly, Neodiprion lecontei*, is native to Michigan and much of eastern North America. The larvae feed in colonies and consume both new and old foliage. During outbreaks, multiple colonies can attack young trees and cause complete defoliation and tree mortality. The preferred hosts in Michigan are jack pine and red pine. Young plantations less than 15 feet in height are at greatest risk. Photo by Michigan Department of Natural Resources forest health technician Scott Lint.*

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Forest Resource Overview

In addition to its 3,200 miles of shoreline and 5.5 million acres of wetlands, Michigan has more forest land than any other state in the Northeast or Midwest. Among the 50 states, Michigan ranks 22nd in land area and 10th in forest land area. Forest land accounts for 19.3 million acres or 53 percent of land in Michigan.

Of these 19.3 million acres:

- 57 percent (11 million acres) is owned by families and private individuals.
- 8 percent (1.5 million acres) is in industrial private ownership.
- 14 percent (2.7 million acres) is in federal ownership.
- 21 percent (4.1 million acres) is owned by the state.

A recent Michigan State University study values Michigan's forest products industry at about $17.8 billion annually. A goal of the Michigan DNR is to increase the economic impact of the timber industry to $20 billion.

Forest recreation and tourism is also an important part of the state's economy. Michigan's state park system, established in 1919, includes over 100 parks and recreation areas covering 285,000 acres. These facilities host over 21 million visitors a year.

The Michigan DNR also manages nearly 140 state forest campgrounds, including a dozen equestrian campgrounds. Michigan state game areas encompass more than 340,000 acres.

The rich diversity of Michigan's urban and rural forests is being threatened by exotic insects, plants and diseases finding their way into the state from around the world.

Invasive organisms like emerald ash borer, beech bark disease and oak wilt are affecting thousands of acres in Michigan and killing millions of trees. Without a plan of action, entire species of native trees are at risk of disappearing from our forests.

The solution to this crisis lies largely in public awareness. Understanding the role humans play in the accidental introduction of exotic pests into our forests is a vital first step in halting the problem.

The 2015 Michigan Forest Health Highlights publication is dedicated to getting the word out to foresters, landowners, arborists, homeowners and community leaders about the work the Michigan Department of Natural Resources and our partners are doing to protect our state's exceptional natural resources.

Michigan's Eastern Hemlock: A Remarkable Tree with a New Problem – Hemlock Woolly Adelgid

Michigan has been fighting the arrival of the hemlock woolly adelgid (HWA), *Adelges tsugae*, for many years. HWA is an exotic insect native to Asia. HWA is currently devastating eastern hemlock stands in 11 northeastern states from Maine to Georgia. These hemlock forests are suffering damaging, often permanent, affects from this insect, including loss of diversity and significant decline in health and vigor. No infested hemlock tree or hemlock forest has exhibited any sign of recovery. Trees of all sizes are affected.

HWA has been detected in Michigan several times in the past decade (see map). These introductions were caused by infested hemlock nursery stock originating from HWA-infested areas of the U.S. In 2001, Michigan's Department of Agriculture & Rural Development (MDARD) enacted an HWA quarantine to stop this movement from infested areas.

Each time HWA has been detected, cooperative efforts between MDARD, the Michigan Department of Natural Resources, Michigan State University and the U.S. Forest Service have stopped this threat to Michigan's hemlock resource. In 2015, a more substantial HWA detection in Muskegon and Ottawa counties brought many state, federal and university resources together to address the most substantial HWA introduction to date. Additional resources needed to fully implement a draft strategy to again remove HWA from Michigan are being sought. Based on the most recent inventories of Michigan forests, more

Hemlock Woolly Adelgid *continued*

than 12 percent of the total area of timberland contains eastern hemlock. Hemlock grows on 2.3 million forested acres.

The Tree

Eastern hemlock is an essential component of Michigan's forest biodiversity. It is a universally accepted symbol of Michigan's old growth forests. Many species of wildlife benefit from the excellent habitat that a dense stand of hemlock provides. Streams draining hemlock forests support more aquatic invertebrate species than streams draining hardwood forests. Brook trout are more common in streams with hemlock in the surrounding forest.

Many of our state and national parks, state forest campgrounds and forested trail systems feature majestic hemlock trees. Their stature, beauty, and the sense of ecological and historical significance they provide visitors are an important part of the state's recreational experience. Eastern hemlock is often planted as an ornamental option because of its relative freedom from insects and disease, good form, pleasant foliage color, and adaptability to shearing.

Eastern hemlock is a slow-growing, long-lived tree that, unlike many trees, grows well in shade. In fact, eastern hemlock is the most shade tolerant of all tree species. It can survive with as little as 5 percent of full sunlight. Hemlock can take 250 to 300 years to reach maturity and may live for 800 years or more.

Wildlife Resource

Wildlife values alone are a strong justification for maintaining hemlock as a component in the northern forest. The value of hemlock stands as winter cover for deer is widely recognized. The dense, closed-canopy of a pure hemlock stand reduces both wind velocity and snow depth. Other animals commonly associated with hemlock-dominated ecosystems are ruffed grouse, moose, turkey, snowshoe hare, porcupine, yellow-bellied sapsucker, red squirrel and red-backed vole. Thirty-seven mammalian and 20 herptile species are associated with hemlock forests in the Lake Superior region.

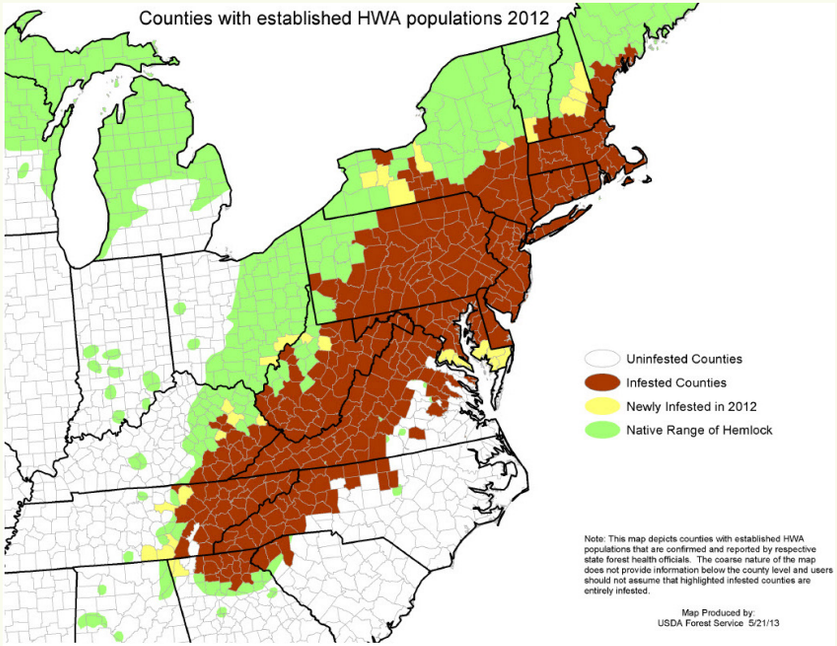
Hemlock-mixed forests are likely an important element in conservation efforts in the Lake States for declining North American songbirds. Elimination of hemlock in northern forest would lead to reductions in the abundance of several bird species, notably black-throated green warbler, Blackburnian warbler, solitary vireo and northern parula.

The Hemlock Woolly Adelgid

HWA was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia. In their native range in Asia, populations of HWA cause little damage to local species of hemlock. However, in the absence of natural controls in eastern North America, and a lack of HWA resistance in eastern and Carolina Hemlock, HWA damage and kill infested trees within a few years. HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee (see map of HWA distribution in eastern U.S. on next page).

HWA damages hemlocks by sucking sap from young twigs. It is a small, aphid-like insect that uses its long, siphoning mouthparts to extract sap from hemlock trees. This feeding causes needles to

Hemlock Woolly Adelgid *continued*



discolor and drop prematurely. The loss of new shoots and needles seriously impairs tree health. Defoliation and tree death can occur within several years.

If established in an area, HWA can easily move to other areas on wildlife, the wind and people's clothing and other gear. Detecting introductions quickly and removing them is critical to keeping HWA from establishing in Michigan.

For more information on the biology and North American distribution of HWA see the U.S. Forest Service Forest Health Protection website dedicated to the hemlock woolly adelgid: http://na.fs.fed.us/fhp/hwa/.

Preventing HWA

Michigan's greatest risk of HWA introductions is through the transport of infested nursery stock and landscape trees. Because of this threat, MDARD enforces a quarantine on hemlock originating from outside the state of Michigan. In 2001, Michigan's Department of Agriculture quarantined the importation of eastern hemlock logs, untreated bark products, seedlings and nursery stock in an effort to limit the threat of HWA.

In support of the Michigan HWA quarantine, DNR Forest Health personnel continue to survey for HWA in areas at risk of introduction and in areas of past introductions. Activities at these sites are supported in part by a Forest Health Protection grant from the U.S. Forest Service.

Hemlock trees killed by hemlock woolly adelgid.

Hemlock Woolly Adelgid *continued*

Managing HWA Introductions

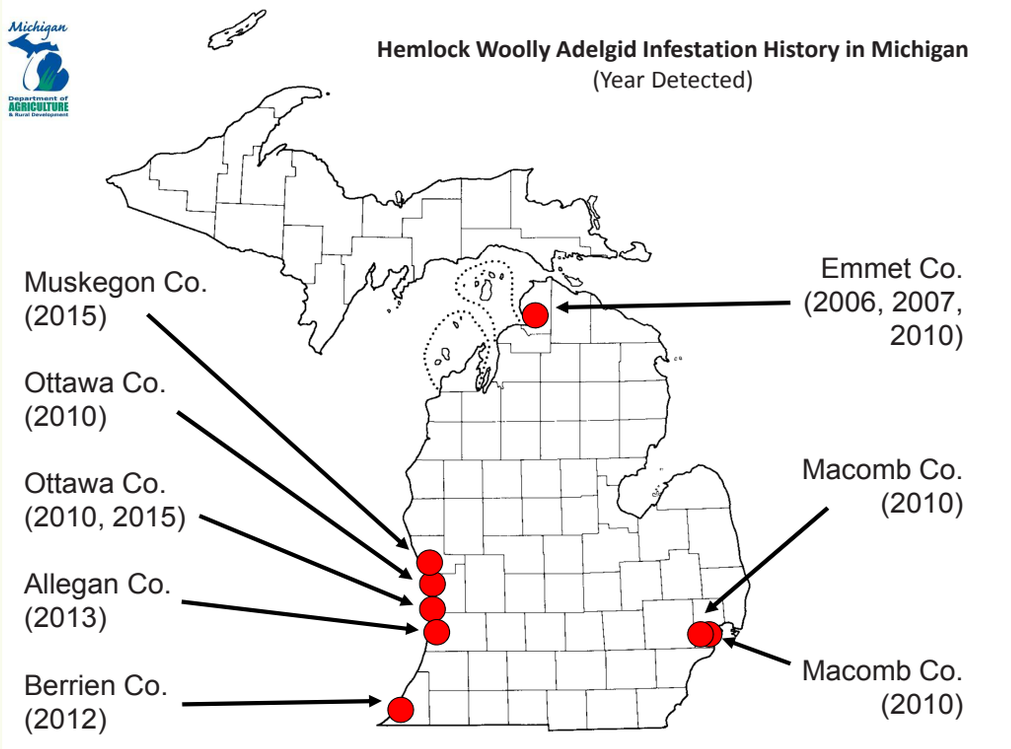
HWA infestations can be very difficult to detect at low population levels. The insect is small and may initially only infest a few branches high in the tree. Because of this, MDARD monitors treated sites for several years to ensure there is not a resurgence of HWA in those areas.

Michigan's HWA quarantine has been in place since 2001. The law restricts the movement of hemlock into the state, and includes a complete ban on the movement of hemlock from infested areas as part of a statewide quarantine. Quarantine details are available by visiting MDARD's Plant, Pest & Pesticide Info page: http://michigan.gov/mdard/0,4610,7-125-2390_46323---,00.html.

If an HWA infestation is suspected, do not remove potentially infested materials from the site. Take photos, note the locations of the affected tree(s) and report the problem to one of the following:

- 1-800-292-3939
- MDA-Info@michigan.gov
- www.misin.msu.edu

Management of HWA in Michigan is a cooperative effort between MDARD, the Michigan DNR and the U.S. Forest Service.



Balsam Woolly Adelgid

The Michigan Department of Agriculture and Rural Development (MDARD) enforces a quarantine to protect the state's balsam fir from the balsam woolly adelgid (BWA). According to the U.S. Forest Service, BWA was accidently introduced into Maine in 1908 from Europe. It now infests firs in southern Canada, the Pacific Northwest and the northeastern United States. In the eastern United States, vast stands of Fraser and balsam fir have been killed, with serious impacts on timber and Christmas tree industries. In the Great Smoky Mountains National Park, 95 percent of Fraser fir has been killed by BWA.

Balsam woolly adelgid is a sap-feeding insect that attacks true firs, including balsam fir and Fraser fir. The BWA causes twig gouting (see image), kills branches, and eventually kills the tree. Small (less than 1/32nd of an inch) purplish-black adult BWA form white, waxy "wool" that covers twigs, branches and stems of infested trees. Smaller, amber-colored crawlers hatch in mid-summer, which is when the risk of spreading the insect by wind and wildlife is highest. BWA affects firs in forests, seed production, landscaping and Christmas tree farms.

"While we don't have BWA in Michigan, it could be introduced into the state's landscape in a number of ways, including on infested nursery stock, firewood, logs and vehicles and then spread by wind, birds and other animals which can carry it for miles," said MDARD Director Jamie Clover Adams. "And, once it's here, it's difficult to detect and eradicate."

The BWA quarantine generally prohibits the shipment of fir nursery stock and fir timber products into Michigan from infested states. Certain low-risk fir products are exempt, including Christmas trees and wreaths and heat-treated timber products. The quarantine also allows fir seedlings grown under an active pest management program to be shipped into Michigan.

Top: *Twig gouting caused by the balsam woolly adelgid (BWA).* ***Bottom left:*** *BWA, small cotton-like balls on balsam fir twigs.* ***Bottom right:*** *White cottony BWA on the trunk of a balsam fir.*

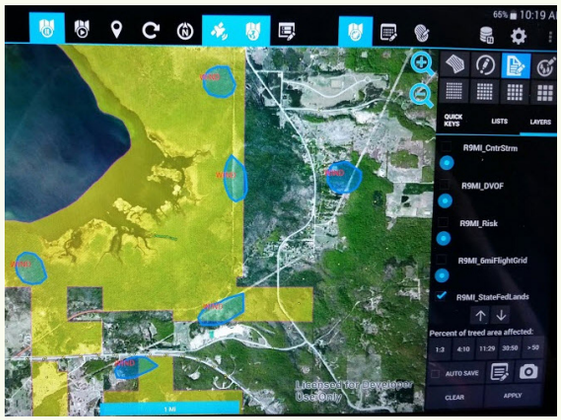
The U.S. Forest Service's Forest Inventory and Analysis Program reports Michigan's balsam fir resource is comprised of 1.9 billion trees. This equates to a volume of 903 million board feet of sawtimber, or 463 million cubic feet of trees. Balsam fir is an important source of pulp and dimensional lumber.

For more info on BWA, visit: www.na.fs.fed.us/pubs/fidls/bwa.pdf.

Aerial Survey & Digital Mobile Sketch Mapping

The Michigan Department of Natural Resources, in cooperation with the U.S. Forest Service, conducts annual aerial detection surveys (ADS) for insect and disease damage over most of Michigan's nearly 20 million acres of forested land. These annual surveys occur throughout the growing season. Surveys are intensified in July when most significant defoliation events are at a peak.

Large areas of defoliation caused by agents such as spruce budworm, jack pine budworm, aspen tortix, forest tent caterpillar and gypsy moth are mapped during aerial survey missions.



Digital Mobile Sketch Mapping screen capture.

Aerial survey data is used to monitor damage and changes in pest populations from year to year, and serve as an early detection tool for newly emerging problems. Michigan's aerial survey data are "rolled up" with other states' data into a national summary and are being used to inform tactical decisions by local forest managers on the ground.

The DNR Forest Health Program aerial surveyors have been participating in the testing of a new data capturing and recording system being developed and deployed by the Forest Service, Forest Health Technology Enterprise Team (FHTET).

The new Digital Mobile Sketch Mapping (DMSM) system introduces

many new and improved features over the Digital Aerial Sketch Mapping (DASM) system currently being used around the country. Beta testing has proceeded well enough that the Michigan Forest Health Program used the new system operationally across the state in 2015. This effort represents the largest set of data collected using DMSM to date.

DMSM offers new efficiencies and capabilities the old system was lacking. The new system uses an Android operating system and is currently being used on several different-sized tablets. This makes it extremely flexible not only for aerial mapping but also for ground checking.

Data collected with the DMSM are synchronized via wireless

Aerial Survey *continued*

connection to a server at FHTET in Ft. Collins, Colorado. This gives all surveyors immediate access to recently collected forest health data. Using this feature, aerial surveyors can provide forest health staff, and other forestry professionals, near real-time access to this information.

This capability provides field staff an efficient method of giving aerial surveyors rapid and accurate feedback about what they're seeing on the ground. The ground-checking process in DMSM allows for edits or comments to be made to the data. This provides timely feedback and a new level of quality control for aerial survey data.

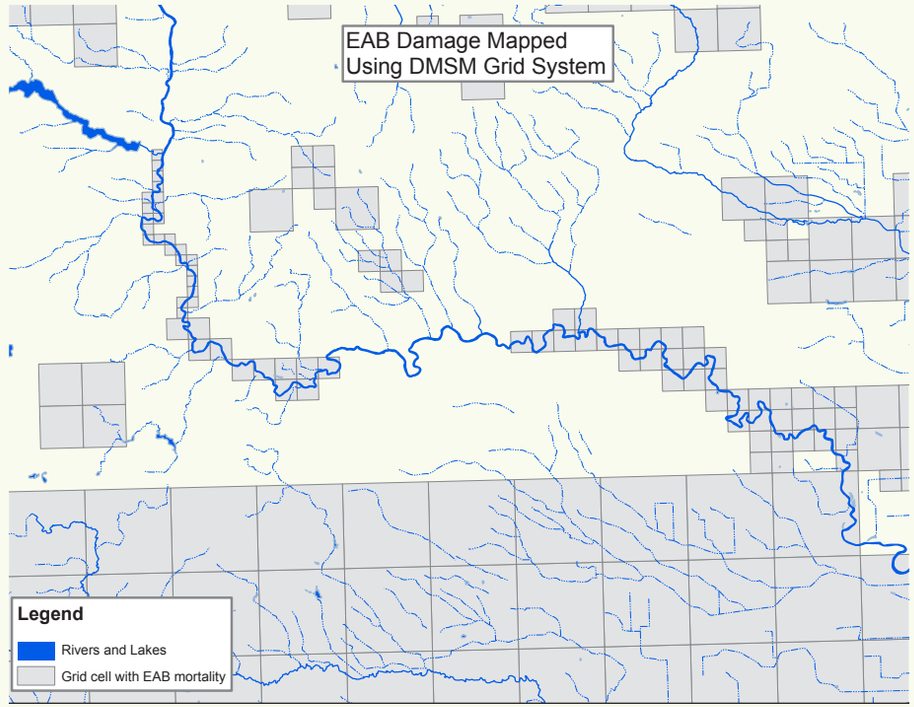
In addition to the traditional mapping using freehand polygons and points digitized on the tablet, the DMSM also introduces a grid cell mapping feature.

Recent severe and widespread insect and disease events, including emerald ash borer and beech bark disease, have been difficult to map accurately because they affect a discontinuous component of large forested areas.

DMSM introduces the option of projecting a series of grid cells across the imagery on the screen. Depending on the scope and intensity of the damage, aerial surveyors can select the appropriate scale grid cell to quickly highlight the affected area.

Information about insect and disease outbreaks within the selected grid cells, including intensity and distribution, is quickly summarized using predefined categories. Multiple grid cells can be selected and summarized at the same time.

The grid cell system was used successfully to collect emerald ash borer mortality for the first time in Iosco and Arenac counties this summer. Note the use of smaller grid cells along riparian areas where the mortality and the host trees are concentrated, compared to the larger grid cells used to capture more diffuse damage in other parts of the landscape.



Digital Mobile Sketch Mapping grid cell mapping emerald ash borer damage.

With this season's successful pilot-testing of the DMSM, the DNR anticipates full rollout of this system in Michigan for the 2016 season.

Insects & Diseases

Healthy and productive forests are comprised of a diversity of native tree, shrub and herbaceous plant species, as well as an even larger number of faunal species for which forests provide habitat. Forested ecosystems have continuously adapted and evolved over thousands of years, as insect, plant and animal species are naturally, intentionally or inadvertently introduced or extirpated from ecosystems. Prevention and mitigation of invasive plants, insects and disease introductions are important for the maintenance of healthy and productive forests.

From "Michigan Forest Resource Assessment & Strategy"
June 2010

Spruce Budworm

It appears that Michigan has entered the beginning years of the next regional spruce budworm (SBW; *Choristoneura fumiferana*) outbreak. The entire western Upper Peninsula, areas in the eastern Upper Peninsula and areas in the northeastern Lower Peninsula were defoliated by SBW for the second consecutive year.

Epidemics of spruce budworm periodically cause extensive defoliation and tree mortality in spruce and fir forests across the northeastern United States and Canada. Historically, epidemics have occurred on a 30- to 50-year cycle. The last epidemic ended in Michigan in 1982.

Spruce budworm damage on new growth.

Budworm populations have been building in isolated areas of susceptible forests in the Upper Peninsula for the past decade. Susceptible forests are those where balsam fir and spruce are stressed and abundant, and where balsam fir average age is greater than 50 years.

Recently, populations have been rising to high levels one year, only to collapse the next.

Beginning in 2014, however, areas of heavy defoliation remained heavy in 2015. In addition, defoliation was much more widespread across the western Upper Peninsula this year. Once

Trees damaged by spruce budworm.

SBW populations become widespread, all spruce and fir trees are subject to some level of defoliation.

The Insect

The SBW is one of the most destructive native insects in the northern spruce and fir forests of the eastern United States and Canada. Periodic outbreaks of the spruce budworm are part of the natural cycle of events associated with the maturing of balsam fir. White and black spruce are also hosts, with limited feeding occurring on tamarack, pine and hemlock.

Since 1909, there have been waves of budworm outbreaks throughout the eastern United States and Canada. The states most often affected are Maine, New Hampshire, New York, Michigan, Minnesota and Wisconsin. SBW outbreaks last for 10 to 15 years and

Spruce Budworm *continued*

Spruce budworm larva.

have resulted in the loss of millions of cords of spruce and fir.

The SBW limits the longevity of balsam fir-dominated and mixed spruce/fir forests in northeastern North America.

Large scale SBW outbreaks cause widespread top kill and tree mortality. Mature and over-mature balsam fir dominated stands are most severely damaged. Susceptible stands often lose 60 to 80 percent of the fir and 20 to 40 percent of the spruce. Mature fir stands may be entirely lost.

The last outbreak in Michigan started in the Upper Peninsula in the late 1960s and ended in the early 1980s. Over 519,000 acres of spruce and fir trees died in Michigan as a result.

The Resource

The vast majority of Michigan's spruce and fir forests are in the Upper Peninsula. Balsam fir provides food and/or cover for animals. Moose rely on balsam fir in winter when it is a major source of food. The use of balsam fir by deer for cover and shelter is well documented. During severe winter weather, especially in northern areas of the white-tailed deer range, lowland balsam fir stands and spruce-balsam fir swamps are used extensively as winter yarding areas.

Balsam fir provide a small part of the diet for both the spruce grouse and the ruffed grouse. Buds, tips, and needles are consumed, and more feeding occurs in winter than in summer. Thickets of balsam fir provide shelter for both birds.

White spruce stands are a source of cover and food for some species of game. Moose and hares frequent these forests but seldom eat white spruce, while red squirrels and spruce grouse live in these forests and also feed on parts of the tree. Prey species (furbearers) such as marten, wolverine, lynx, wolves and others also reside in these forests.

The most important products made from balsam fir wood are pulpwood and lumber. The major use of balsam fir lumber is for light-frame construction. Minor uses include paneling, crates, and other products not requiring high structural strength.

White spruce is a source of wood fiber and lumber products as well. Lesser-known uses of white spruce wood are for house logs, musical instruments, paddles, and various boxes and containers.

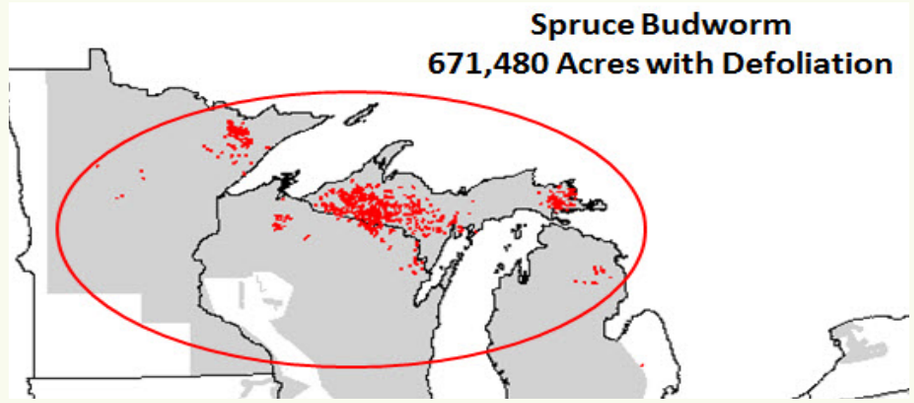
U.S. Forest Service Forest Inventory and Analysis estimates that Michigan has 174 million balsam fir trees with a volume of 919 million board feet, and 69 million white spruce trees with a volume of 2,333 million board feet.

Spruce Budworm *continued*

Management

Current management guidance is to harvest spruce and fir when they reach rotation age of 50 years, or salvage harvestable stands with significant SBW damage. The best long-term SBW strategy is to schedule harvests over time with the goal of creating widespread distribution of stands with different spruce-fir age classes.

SBW is the primary limiting factor affecting mature and over-mature spruce and fir. Increasing the diversity of age classes and keeping stand age near 50 years will reduce total tree mortality and growth loss. This will also decrease the number of highly vulnerable stands when SBW outbreaks occur. In turn, this increases the amount of thermal cover available for wildlife.



The Michigan Department of Natural Resources is evaluating at-risk forests on state land. The goal is to harvest high value, accessible spruce and fir trees before they are lost to the SBW. About 20 percent of Michigan's spruce and fir trees grow on state forest land, with 24 percent on federal lands and 56 percent on private/industrial ownership. Opportunities to harvest spruce and fir from these lands are often limited due to poor access and to restrictions that limit harvesting activity on sensitive sites like protected river corridors.

For answers to commonly asked SBW questions, including how to protect landscape spruce and fir, visit http://www.michigan.gov/documents/dnr/SBW_FAQ_-_FINAL_492925_7.pdf?20151215134857.

Redheaded Pine Sawfly

The redheaded pine sawfly, *Neodiprion lecontei*, damaged young plantation red and jack pine in areas of the Northern Lower Peninsula for the second year. A site in Montmorency County is estimated to have 100 acres heavily defoliated by the sawfly, with several hundred acres affected to a lesser degree.

Reports of sawfly activity were numerous from the Huron National Forest to the Tawas City area. The eastern Upper Peninsula also reported sawfly populations in 2015.

Sawfly outbreaks tend to build regionally. If these populations continue to build in 2016, young red and jack plantations should be monitored in late June and early July while larvae are small. The sawfly is easily controlled with pesticides.

The Insect

The red-headed pine sawfly is an important defoliator of young two-needle pines. Plantations less than 15 feet tall are most susceptible to economic injury.

Heaviest infestations occur commonly on pines growing under stress, particularly those at the edges of hardwood forests, on poor soils, or where there is heavy competitive vegetation.

The sawfly prefers edge trees. Repeated defoliation can cause top kill, forking and tree mortality. A single moderate to heavy defoliation stunts height growth of infested trees. Complete defoliation is usually sufficient to kill red pine and jack pine.

The larvae feed in colonies containing a few to over a hundred larvae. Early damage is similar to that of most other coniferous-feeding sawflies. It is characterized by the reddish-brown, straw-like remains of needles partially consumed by the young larvae. Older larvae devour the entire needle, generally stripping a branch of all its foliage before feeding on another.

Top: *Redheaded pine sawfly larvae.* ***Bottom left:*** *Damage caused by the redheaded pine sawfly.* ***Bottom right:*** *Sawfly laying eggs in needles in June.*

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

White Pine Decline

There have been interesting new developments in the search to identify the cause of white pine dieback and mortality in the northcentral Lower Peninsula. Researchers in the southeastern U.S. have been investigating a similar problem affecting white pine there. Recently, a scale insect, *Matsucoccus macrocicatrices*, has been implicated in dieback and mortality of young white pine trees in several states, including Georgia, North Carolina, South Carolina, Tennessee, Virginia and West Virginia.

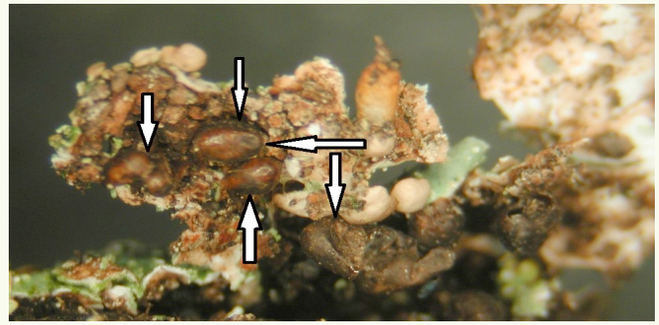
Scales are sucking insects that insert tiny, straw-like mouthparts into bark, fruit, or leaves of trees, shrubs and other perennial plants. While some species of scales cause no apparent harm, others can seriously damage host plants.

In summer 2015, the *Matsucoccus* scale was confirmed on samples of white pine collected in Michigan's northern Lower Peninsula. Samples came from state forest land in eastern Crawford County. This is one of several areas we've been monitoring since damage was first reported in 2008 by Michigan Department of Natural Resources foresters in the Grayling Forest Management Unit.

The dieback and mortality occur on understory white pine seedlings and saplings along or near the Au Sable and Manistee river corridors. Often, affected white pines are growing below an oak overstory.

Damage is associated with small cankers that occur on branches of affected white pine. Often, these cankers are below, or in proximity to, the fronds of lichen widely distributed in these forests.

Lichens are organisms made up of algae and fungi living together in a mutually beneficial relationship. Harmless to their host, they frequently grow on the bark of a variety of forest tree species. In Michigan Department of Natural Resources surveys, *Matsucoccus* scale is most often associated with a particular species of lichen, *Melanelixia subaurifera*, commonly found on branches and small twigs of white pine trees in northern Michigan.



Scale insect identified by arrows.

Interestingly, *Matsucoccus* scales has been known for some time in forests in the Canadian Atlantic Maritimes, as well as in New Hampshire and Massachusetts, but have not been found to cause significant damage there.

Prior to the identification of this scale on white pine in Michigan, pine spittlebug, *Aphrophora parallella*, was being investigated as a possible culprit. Pine spittlebug is a native pest of Lake State conifers. Feeding by spittlebug nymphs and adults during periodic outbreaks can cause branch dieback and needle discoloration. Recent findings by the southern researchers suggest that feeding scars previously attributed to pine spittlebugs may, in fact, be caused by *Matsucoccus* scales.

It appears the scale has a two-year life cycle in Michigan, with quite a bit of overlap in the life stages.

There is evidence a fungus, *Therrya pini*, may also be a factor in the dieback and mortality. Feed damage by the scale may be creating opportunities for the fungus to invade the tree.

Heterobasidion Root Disease

The Michigan Department of Natural Resources Forest Health program, in cooperation with Michigan Technological University, has intensified detection efforts for the fungal pathogen *Heterobasidion irregulare*. Field surveys to identify *Heterobasidion* root disease (HRD), as well as spore trapping surveys to determine the potential presence of the fungus, were conducted in both the Upper and Lower peninsulas this fall. These surveys resulted in a number of new detections.

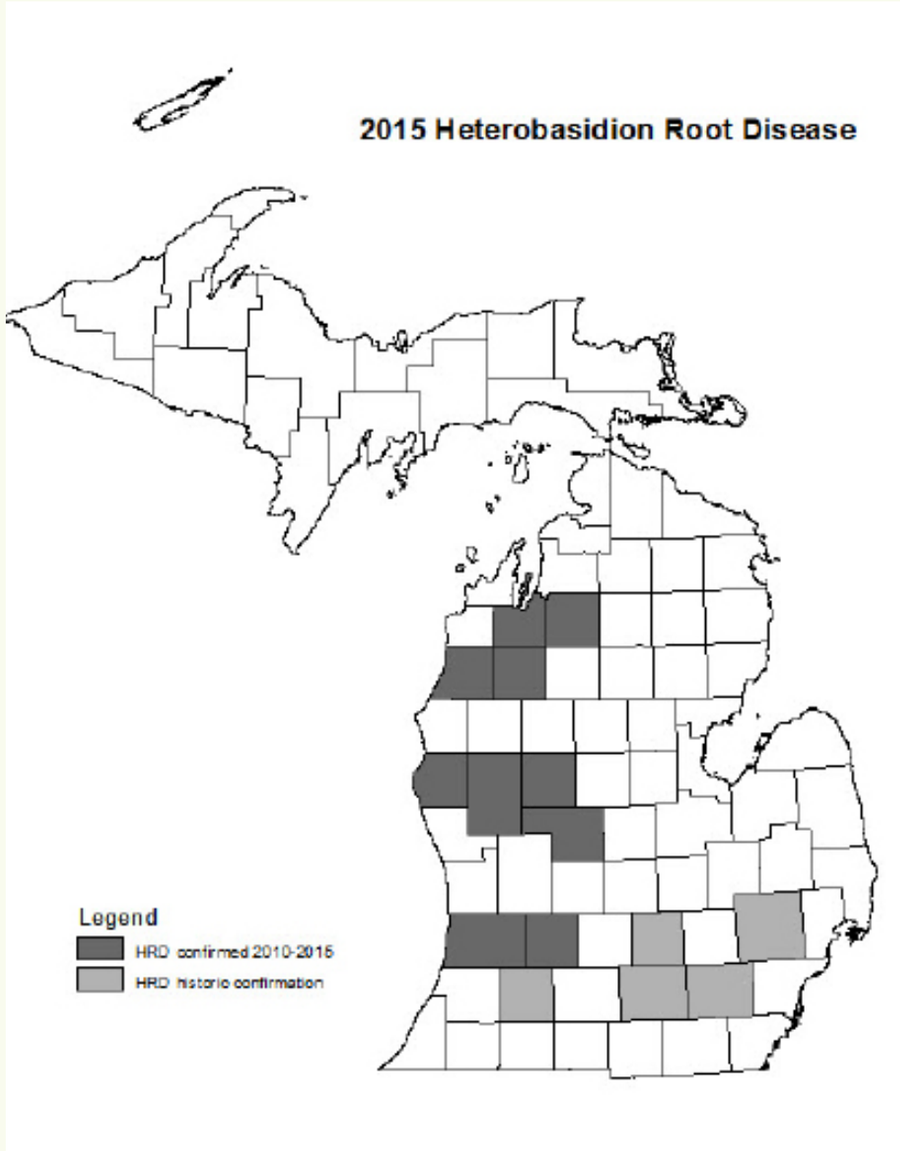
This project is a collaborative effort with forest health partners in Wisconsin and Minnesota. It is being funded by a U.S. Forest Service Forest Health Monitoring, Evaluation Monitoring grant.

Trees infected by HRD suffer from thinned crowns, reduced height and trunk diameter, as well as slower shoot growth. Over time, circular pockets of dead and dying trees within a forest mark the progression of the disease.

Heterobasidion irregulare (formerly *Heterobasidion annosum* p-type), is considered among the most destructive fungi in North American forests. Unlike many forest insects and diseases that are attracted to stands stressed by lack of management, HRD is most commonly found in actively managed forest stands. Fresh cut stumps provide an ideal entry path for airborne spores of HRD.

Stands that have been thinned multiple times are at high risk of infection if spores from the fungus are present and successful at colonizing fresh cut stumps. Proximity to established disease centers with mature fruiting bodies increases risk due to the presence of increased inoculum. Red pine, white pine and jack pine are at risk of infection as are to a lesser degree white spruce, balsam fir, and tamarack.

There is concern that a statewide increase in the number of pine



Heterobasidion Root Disease *continued*

plantations, as well as the practice of multiple thinnings over the life of the plantations, may actually favor the proliferation of HRD. Several sites where the disease is well-established and causing significant damage have been detected in Michigan. All of these sites have a history of active management. HRD is a native pathogen but, under these conditions, it has the potential to behave like an invasive organism and cause significant mortality.

Forest Health staff will continue to delimit the extent of this disease in 2016. Efforts are underway to establish a timeline for the disease on some of the newly detected sites. This will help determine when the initial infection may have occurred and how quickly the disease is spreading across these sites in Michigan.

Monitoring plots have also been established in a plantation where HRD is present to measure the rate of spread and rate of wood volume loss as the disease progresses over the next few years.

New detections were made this year in Barry, Grand Traverse, Kalkaska, Montcalm, Newaygo and Oceana counties. The disease has been detected on private, private industrial, state game areas, state forest land and national forest land.

With active HRD infections in Michigan, across much of Wisconsin and the Canadian province of Ontario, early identification and containment of HRD in Michigan remains a forest health priority.

Top: *Aerial view of damage caused by* Heterobasidion *root disease near the Muskegon River.* ***Bottom left:*** *The spore-producing fruiting bodies of* Heterobasidion Irregulare *formed on a red pine stump in Barry County.* ***Bottom right:*** *Freshly cut discs from red pine are used to mimic a fresh cut stump and are exposed for 24 hours to survey for the presence of* Heterobasidion *spores.*

Oak Wilt

Oak wilt is an aggressive tree disease that affects many species of oak (*Quercus* spp.). It is one of the most serious tree diseases in the eastern United States, killing thousands of oaks each year in forests, woodlots and home landscapes. Once introduced to an area, oak wilt spreads through root connections to adjacent oak trees.

Oak wilt was first identified in 1944. The fungal pathogen that causes the disease, *Ceratocystis fagacearum*, is an exotic pathogen. Difficulty in isolating and identifying the fungus delayed recognition of the extent of its impact until the 1980s.

The oak wilt fungus moves in two ways: it is transported from tree-to-tree through underground root connections, and it is spread overland by sap beetles that carry oak wilt spores.

Oak wilt invades new areas when the fungus is carried by sap beetles from infected wood (e.g., a tree, log or firewood) to a fresh wound on a healthy oak. Trees killed by oak wilt produce spore pads the following year. Sap beetles are attracted to these pads, where they feed and pick up spores. The beetles are also attracted to fresh wounds.

Oak wilt infects a wounded oak when the tree is visited by spore-carrying sap beetles between April 15 and July 15. Most new oak wilt outbreaks can be traced to damage from pruning, construction and other tree-wounding activities, and from heavy winds.

Oak wilt is established widely in the southern Lower Peninsula, with spotty distribution in the northern Lower and Upper peninsulas. As people move northward into forested areas, the risk of spreading this disease increases. People unknowingly cut oak wilt-killed trees for firewood. Infected wood is then taken to camps or on camping trips, where it will serve as a source of inoculum to infect nearby oaks wounded in the spring or early summer.

Pulling stumps of newly infected trees prevents the oak wilt fungus from moving through roots to other trees.

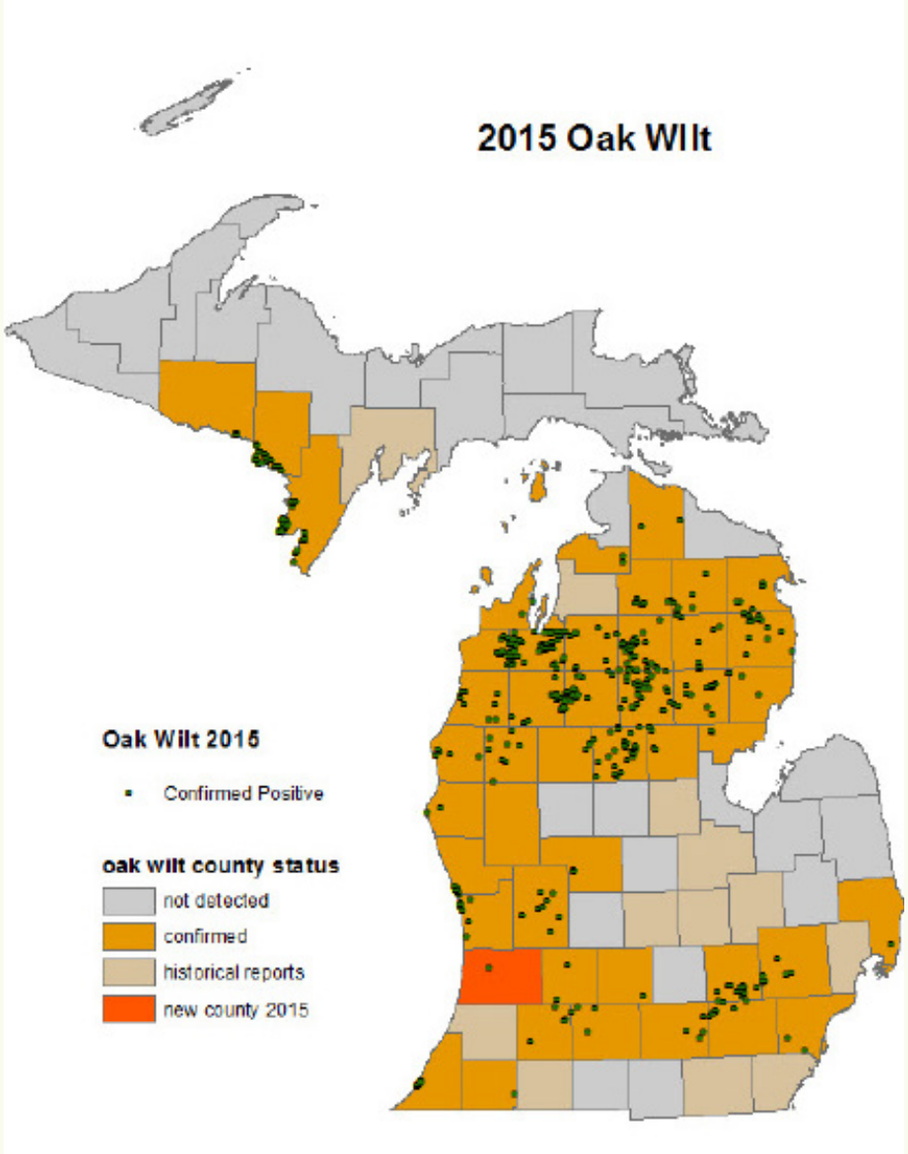
Michigan's Oak Resource

U.S. Forest Service Forest Inventory and Analysis (FIA) data shows there are 149 million red oak trees in Michigan greater than 5 inches in diameter. There are 68 million red oak with diameters greater than 11 inches. This equals a volume of 11.9 billion board feet growing on 3.9 million acres of Michigan forest land. Ownership of this oak forest land is 67 percent private, 22 percent state and local government, and 11 percent federal.

Detecting, Confirming and Reporting Oak Wilt

Knowing the number and distribution of oak wilt pockets is crucial

Oak Wilt *continued*



to understanding the potential short- and long-term impacts of oak wilt on Michigan's oak resource. However, confirming oak wilt as the cause of oak mortality is not always easy. Not all oak mortality is caused by oak wilt. A good deal of oak mortality in Michigan in the last decade is the result of drought, late-spring frosts, two-lined chestnut borer and over-mature northern pin oak forests. Additionally, new infections started by movement of firewood can be difficult to confirm.

Often, a newly killed tree is felled and cut into firewood. This firewood can serve as a source of new infections, whether it's stacked where it was cut, or is moved to areas near healthy oaks. Removing the tree does not stop the disease. Neighboring oaks will often begin dying in a year or two. Generally, it isn't until more oak trees start dying that people begin seeking answers to the cause.

The Michigan Department of Natural Resources and Michigan State University have stepped up efforts in recent years to detect and confirm oak wilt in Michigan.

A grant from the U.S. Forest Service is funding a statewide effort to detect, confirm and record oak wilt occurrence. As this information becomes available, researchers can begin to investigate the distribution and scale of the problem. Knowing where oak wilt occurs also helps provides guidance for prevention and suppression activities.

As part of this effort in 2015, DNR Forest Health Program staff conducted oak wilt training sessions for Ontario Ministry of Natural Resources staff and Michigan Forestry Assistance Program (FAP) foresters. These training sessions were conducted in the field in the northern Lower Peninsula with an emphasis on field detection and confirmation. The intent was to utilize FAP foresters and local

Oak Wilt *continued*

Conservation Districts to further detection, outreach and education efforts across Michigan.

In 2015, the Michigan Invasive Species Grant Program (MISGP) awarded funds to the Dickinson Conservation District to map and treat oak wilt on non-industrial private forestland (NIPF) in Michigan.

The grant project has two goals:

- Increasing the number of skilled individuals in the detection, confirmation, and management of oak wilt disease.
- Treating confirmed oak wilt sites in Dickinson, Menominee and Alpena counties.

Since the training, FAP Foresters have conducted more than 150 oak wilt-related site visits and confirmed 46 oak wilt sites around the state.

The first oak wilt treatments focused on three ownerships in southern Menominee County near the town of Wallace. Eleven oak wilt epicenters, totaling 31 acres, were treated by installing 12,249 feet of root-graft barriers with a vibratory plow. The landowners have arranged for the removal of all red oaks within the root graft barriers before April 2016.

A.J. Campbell, Forestry Assistance Program forester, designed the treatments and DDT Construction, Inc. installed the root-graft barriers.

Treating Oak Wilt on State Forest Land and in State Parks

Upper Peninsula

The Forest Service has provided Oak Wilt Suppression funds to help remove oak wilt from Michigan's forests. The DNR and Michigan State University Extension worked together in 2015 to:

- Remove oak wilt from state forest land in the Upper Peninsula by detecting and treating infection centers.
- Educate affected communities to prevent the reintroduction of oak wilt.
- Demonstrate an approach that can be used for detecting and effectively removing the threat of oak wilt throughout Michigan.

This year's project focus was the Shakey Lakes Area of Menominee County. Thirty five oak wilt pockets totaling 116.5 acres were isolated by creating 26,845 feet of root-graft barriers with a vibratory plow. All red oaks within these pockets will be removed via timber sales before April 2016. All sites were reviewed and treatments approved by the U.S. Fish and Wildlife Service, affected Native American tribes and the State Historic Preservation Office.

Michigan State University Extension continued to evaluate past oak wilt suppression efforts. Treated areas remain free of oak wilt with few exceptions. Since the beginning of oak wilt control efforts in this area in 2004, the size of epicenters has grown progressively smaller. Many of the 2015 epicenters were only one or two years old, averaging 1.7 acres. Although much has been achieved, untreated oak wilt pockets remain. Diligence will be needed as we strive to remove the threat of oak wilt to the Upper Peninsula's oak resources.

Lower Peninsula

Efforts to control and suppress oak wilt in the northern Lower Peninsula were smaller in scope this year with treatments concentrated in Grand Traverse, Benzie, Kalkaska and Missaukee counties. In addition, two sites on the Huron National Forest in Iosco County were treated.

Oak Wilt *continued*

The vibratory plow blade used to treat infected stands of oak was specially designed and built at the Michigan Department of Natural Resources' Forest Fire Experiment Station in Roscommon. The plow cuts narrow trenches 5 feet deep to separate underground root systems, preventing further spread of the oak wilt fungus to uninfected trees.

It has been standard practice on state land to remove all red oaks from within these treatment lines to prevent the progression of the disease and the formation of pressure pads. This has been at times labor intensive and logistically challenging.

In response, two smaller sites were selected this year and the remaining red oaks within the treatment lines at these sites were treated with injections of propiconazole in hopes of preventing the development of symptoms.

The combination of vibratory plowing to stop underground transmission and the suppression of symptoms to prevent mortality and the production of spore producing pressure pads will stop the spread of the disease at these sites. These sites will be monitored over the next five years to evaluate efficacy of this approach.

Stump pulling was also used as a part of the northern Lower Peninsula suppression project on a site where a new infection was detected. If new infections to damaged trees are detected in the summer when the infection first occurs, stumps can be pulled, severing root connections and preventing the spread of the fungus into the root system. This approach works well on single trees where early detection and confirmation is possible. The site treated using this technique resulted from damage that occurred in a timber sale during the first week of June.

The Michigan Department of Natural Resources Forest Health Program is testing use of funcides as a potential treatment option of oak wilt.

Beech Bark Disease

Since its discovery in Michigan in 2000, beech bark disease (BBD) has spread widely through Michigan's forests. This disease is triggered by a white scale insect that attaches to bark and feeds on sap. Damage from this feeding allows one of two *Neonectria* fungi to invade the tree. The fungus inhibits the flow of sap through infested portions of the tree, causing a general decline in tree health and eventually killing the tree.

Controlling the natural spread of the disease is not feasible because both the scale and fungus are moved by wind. Scales are also moved by birds, bears and other animals feeding on beech nuts in the fall.

An infested tree is "painted" white by the tiny scale insects. A scale-infested tree may still have healthy-looking foliage, even though the trunk is weakened by the fungus. Infected trees are subject to breakage, a process called beech snap. The trunk breaks in half somewhere below the tree's crown.

Trees prone to beech snap are deemed "hazard trees" and are removed from state parks and campgrounds.

DNR Timber Sales Hauling Restriction

Because beech scales can be moved long distances, there has never been a quarantine established. However, the Michigan Department of Natural Resources enforces a timber sale restriction to help slow the spread of beech scale from infested to non-infested counties. The restriction is based on a map of currently infested counties and is posted on the DNR Forest Resources Division Forest Health web page: www.michigan.gov/foresthealth.

American beech wood products with bark still attached, other than chips, are not to be transported from counties infested with beech

Aerial view of forest damaged by beech bark disease.

scale to or through uninfested counties in the Lower Peninsula or to Wisconsin from July 15 to Nov. 15. Beech scale is mobile this time of year and can move from infested wood to live beech.

A map showing counties in the Lower Peninsula currently infested with beech scale can be found at: www.michigan.gov/foresthealth.

Resistant American Beech Project

Since 2002, the DNR has been working with Dr. Jennifer Koch at the Northern Research Station (NRS) of the U.S. Forest Service to select and breed American beech trees for resistance to BBD.

Beech trees resistant to BBD are resistant to the beech scale. Cuttings from potentially resistant beech are sent to the NRS where they are grown and tested for scale resistance. Techniques to propagate resistant trees through grafting have been developed,

Beech Bark Disease *continued*

and genetic tests of full- and half-sibling families have demonstrated that BBD resistance is heritable. These genetic studies suggest that when both parents are resistant, approximately 50 percent of the progeny can be expected to be resistant.

Currently, the project is focusing on identifying, selecting and propagating resistant beech for establishing seed orchards. The DNR Forest Resources and Wildlife divisions have joined forces to ensure that these orchards are established.

The goal is to provide seed to regenerate resistant seedlings for restoration plantings. The vision is the restoration of Michigan's American beech resource.

So far, five different beech bark disease-resistant parent combinations have produced an average of 52 percent resistant progeny. Subsets of seedlings from these families were out-planted in November 2011 in the Upper Peninsula in an area heavily impacted by BBD. These trees are within an exclosure and will be monitored annually for growth characteristics and continued scale resistance.

Progress Report on Beech Scale Resistance Project
U.S. Forest Service & MDNR

Title: Identification, Propagation and Genetic Analysis of Beech Scale-Resistant American Beech trees for the Development of Seed Orchards in Michigan

Dr. Jennifer Koch, U.S. Forest Service, Northern Research Station, Delaware, Ohio

Project Objective: To develop beech bark disease-resistant

Collecting scions from resistant beech.

American beech seed orchards and seed production areas for restoration of aftermath forests in Michigan.

Progress:

1. Establishment of BBD-resistant seed orchards at the Hardwood Tree and Regeneration and Improvement Center (HTRIC) and the Kellogg Experimental Forest: Installation of two replicate seed orchards was initiated in spring 2015. Upon completion, each site will contain eight grafted ramets of each of 22 different resistant genotypes (a total of 176 trees) collected from state land in the Upper Peninsula or from the Hiawatha National Forest. A ramet is an individual member of a clone group. At the HTRIC site 118 trees were planted and another 66 trees were planted at the Kellogg orchard site. Both orchards are on schedule to be

Beech Bark Disease *continued*

Beech tree heavily infested with beech scale in the eastern Upper Peninsula. Photo by Dr. Joe O'Brien, U.S. Forest Service.

completed in spring 2016.

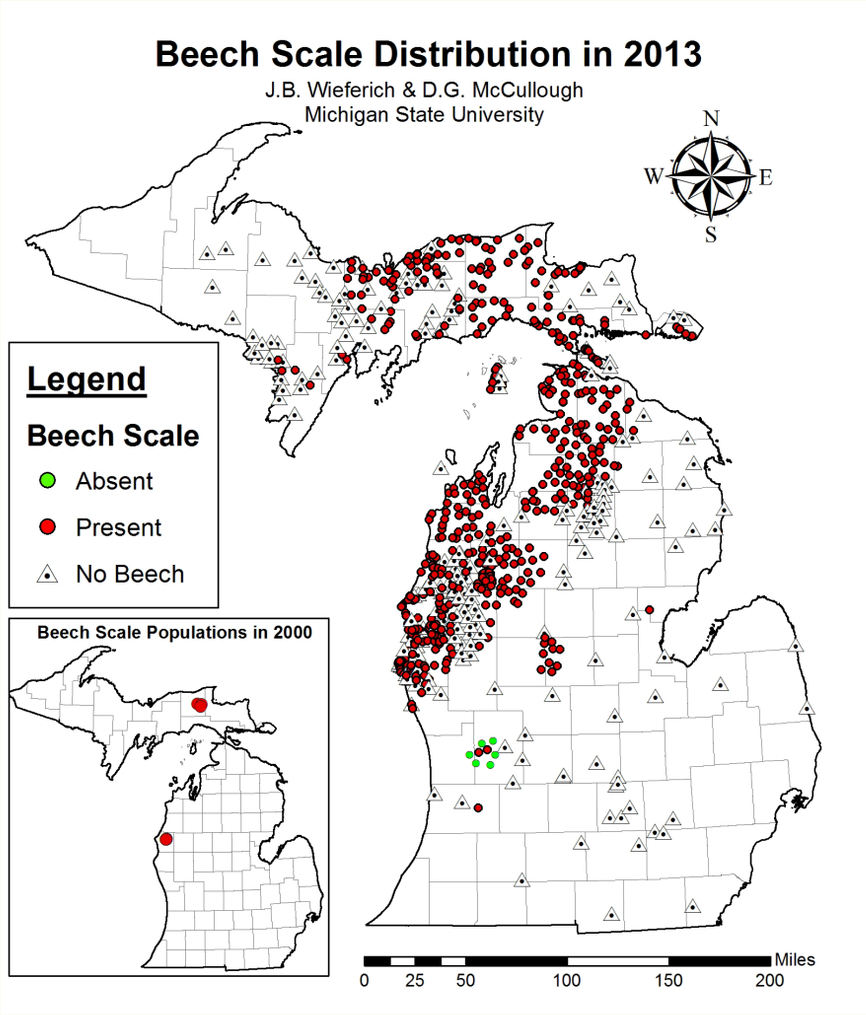
2. Grafting resistant beech genotypes for seed orchards: A total of 264 graft attempts resulted in the production of 212 successful new grafts. This includes the 168 grafts that will be used to complete the HTRIC and Kellogg seed orchards. These grafts were transported to the HTRIC in October 2015 for overwintering and will be planted in spring 2016.

3. Beech Scale Resistance Screening: Beech scale egg bioassays were set up in the summer 2014 (previous bioassay attempt in 2013 failed due to a misunderstanding that resulted in treatment of the test trees with insecticide, making the data invalid) on 140 members of an R x R mapping family at Holden Arboretum. Data was collected in August 2015 and still indicated a residual effect from the insecticide treatment of 2013, so the findings are not valid. The test trees were also heavily infested with oyster shell scale. The decision was made to bring the mapping family back to the Delaware lab for cleanup of the oyster shell scale and to give the trees a year to recover prior to attempting any additional scale bioassays. The susceptible control trees included with the mapping family that had also been accidentally treated with insecticide in 2013 were re-challenged along with a set of susceptible controls that had not been treated with insecticide. The data from these will be collected in summer of 2016 and if all susceptible controls are found to be equally highly infested, it will indicate that the residual insecticide effect is low enough to allow a successful re-testing of the mapping family in 2016.

In addition to the mapping family egg bioassays, two small genetic families that had at least one resistant parent from Michigan were also challenged in 2014 and the data was collected on these families in August 2015. These families had never been treated with insecticide, so the results were informative and indicated that each Michigan parent tree produced enough R progeny to be retained in the seed orchards. Family 1229 X 1216 had 23 R (resistant), 3 I (intermediate) and 12 S (susceptible) progeny and family 1229 X D-9-1 had 16 R and 19 S progeny. The resistant progeny will be retained for future outplantings.

Bioassays were also set up in August 2015 to confirm the resistance off four parent genotypes included in the seed orchards that have not been previously tested. Two ramets of each genotype were challenged with scale eggs and the data will be collected in August 2016.

Beech Bark Disease *continued*



4. Seedling production: We are continuing to rear the 374 seedlings from 16 different combinations between seven different resistant Michigan parents. They are slated to be challenged in bioassay experiments in summer 2016. These seedlings provide genetic data and quality control on the performance of parents destined for inclusion in seed orchards. Once scale resistance data is collected, resistant seedlings can be used in research plantings to study the silvicultural requirements for successful reintroduction of resistant beech in aftermath forests. In the longer term, such a planting can be managed to become a seed production area.

5. Rootstock production: Approximately 1,500 beechnuts were collected from four different trees at Dawes Arboretum in Newark, Ohio. These parent trees have routinely produced viable seed that have performed well as rootstock. The beechnuts are currently in cold stratification and when germination begins in January/ February 2016, they will be sown in containers in the greenhouse. They should produce rootstock that can be used for grafting in winter 2017 and 2018 and would be suitable for grafting Lower Peninsula resistant trees to be installed at the Michigan Tree Improvement Center in Brighton.

Cooperative Beech Bark Disease Research Project
Michigan State Cooperative Tree Improvement Program/
Michigan State University Tree Research Center

The Michigan State Cooperative Tree Improvement Program (MICHCOTIP) continued to assist the DNR and U.S. Forest Service in the establishment of a beech seed orchard that will provide planting stock resistant to beech bark disease (BBD). MICHCOTIP continued to maintain the grafted beech seed orchard at the DNR's Tree Improvement Center (TIC) in Brighton, Michigan, including controlling weeds around surviving trees and maintaining fencing and irrigation lines.

In 2015 work began on the establishment of a second seed orchard

Beech Bark Disease *continued*

at MSU's Kellogg Forest, located near Augusta, Michigan. The development of the Kellogg orchard was necessary because the low soil fertility at the TIC could not support the growth necessary for the production of large quantities of beechnuts. The TIC beech orchard site will continue to be used for non-orchard purposes. At Kellogg Forest, 2.3 acres were prepared for planting by burning and applying a broadcast application of 2,4-D and glyphosate. A 7-foot-high woven plastic deer exclosure was constructed around the site prior to planting. A map of the new orchard was created using software that helped maximize the distance between clones.

Whitewashing of beech bark caused by beech scale.

Upon completion, the orchard will contain 176 ramets of 24 clones known to be resistant to BBD on 25' x 25' hexagonal spacing. This design was implemented in the field by staking each ramet planting location and applying glyphosate to control competing vegetation. Fifty-five ramets were planted during spring 2015, with the remainder expected to be planted in spring 2016. The orchard was maintained throughout the growing season with multiple mowings and herbicide applications.

Growth and survival of the ramets planted spring 2015 was excellent, with the loss of only two trees.

Asian Longhorned Beetle

The Asian longhorned beetle (ALB) is an exotic pest that attacks several species of North American hardwoods, including all species of maple. ALB has been detected in New York City, Chicago, New Jersey, Massachusetts and Ohio in the United States, as well as in Toronto, Ontario.

ALB continues to infest trees in Massachusetts and New York. The infestations in Chicago, New Jersey, and Toronto have been eradicated.

Closer to home, the infestation in Clermont County, Ohio, continues to thwart eradication efforts. Nearly 1.7 million trees have been surveyed, and 16,340 infested trees and 60,247 high-risk host trees have been removed. This infestation is of particular concern here in Michigan, where a potentially devastating load of infested firewood is only a four-hour drive from our border. Public education remains a critical tool in our efforts to keep ALB out, as firewood movement continues to be the likely mode of entry for most exotic forest pests.

The Michigan Department of Natural Resources Forest Resource Division's Forest Health Program, in cooperation with DNR's Parks and Recreation Division (PRD) continues to conduct intensive surveys for ALB. Trees near fire rings that may have been exposed to infested firewood are targeted. Zip codes are used to identify campsites visited by campers from ALB-infested areas of the country. To date, no ALB have been detected.

This is the fifth year the PRD surveyors have carefully searched for signs of ALB in 73 state parks and recreational facilities. This effort was initially support by a U.S. Forest Service grant. With the expiration of the federal grant, PRD adopted and resourced the ALB survey program, along with surveys for other invasive forest pests like hemlock woolly adelgid and oak wilt.

ALB continues to be intercepted in warehouses and at ports in many areas of North America. Quarantines have been established to prevent these introductions and to prevent accidental spread of ALB from infested areas. All infested trees are being removed, chipped and burned. Regulations on solid wood packing material from China have

Asian Longhorned Beetle *continued*

Asian longhorned beetle surveyors attend an annual refresher training session.

been established by the Animal and Plant Health Inspection Service.

The Insect

The Asian longhorned beetle, *Anoplophora glabripennis*, is a destructive wood-boring pest of maple and other hardwoods. ALB was first discovered on several hardwood trees in the United States in Brooklyn, New York, in August 1996. ALB is believed to have been introduced into the United States from wood pallets and other wood packing material accompanying cargo shipments from Asia.

Asian longhorned beetles favor maple trees, but infestations have also been discovered in horse chestnuts, poplars, willows, elms, birch and black locusts.

ALB adults are large (3/4 to 1-½ inches long) with long black and white banded antennae. The body is glossy black with irregular white spots.

Eggs are deposited in niches that are chewed into the bark on tree trunks and branches. As larvae mature, they enter the heartwood of the tree, destroying the value of the wood. Feeding by large numbers of beetle larvae eventually weakens and kills trees.

Adult beetles emerge the following summer through 3/8-inch diameter holes in the bark. Structural weakening of trees by tunneling larvae also poses a danger to pedestrians and vehicles from falling limbs or trees during wind and/or ice storms.

For more information about ALB, visit www.asianlonghornedbeetle.com.

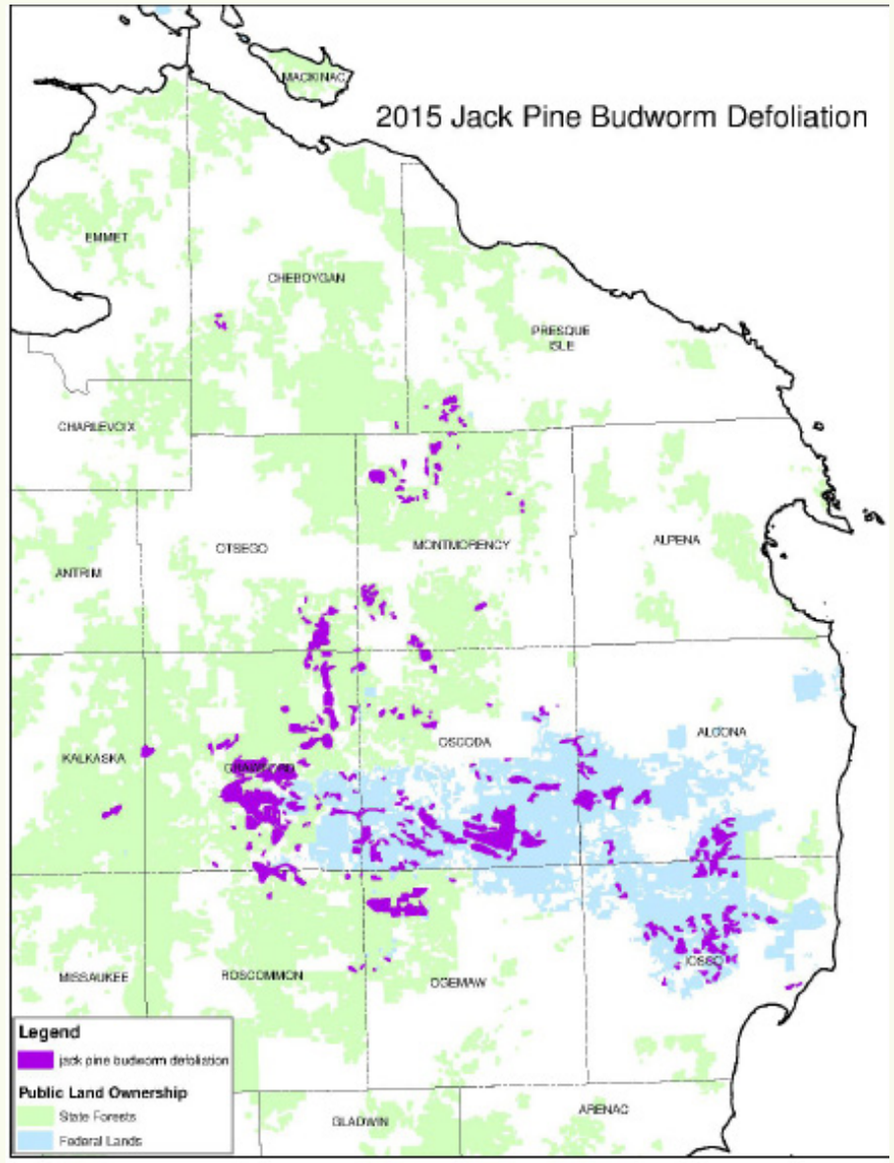
Top: *Emergence holes caused by the Asian longhorned beetle (ALB).* ***Bottom:*** *Cross-section of ALB damage to a stem.*

Jack Pine Budworm

Jack pine budworm populations continued to build slowly in 2015. There was a 15 percent increase in aerial survey detection of budworm defoliation in 2015. Most of the damage occurred in jack pine stands in the central and eastern areas of the northern Lower Peninsula. Approximately 1,000 acres of defoliation were also mapped on the east end of the Hiawatha National Forest in Chippewa County in the Upper Peninsula. In total, nearly 118,000 acres were defoliated by jack pine budworm in 2015.

The jack pine budworm, *Choristoneura pinus*, is a native insect to Michigan. Periodic outbreaks can lead to dieback and mortality in older, over-mature jack pine stands. Current management practices of harvesting older stands of jack pine help to reduce the risk of widespread mortality.

Defoliation caused by jack pine budworm.



Eastern Larch Beetle

The eastern larch bark beetle (ELB), *Dendroctonus simplex*, continues to damage tamarack (*Larix larcinia*) throughout the Upper Peninsula. Historically, once they become epidemic, ELB act more as a primary invader and attacking healthy stands.

According to the Forest Insect & Disease Leaflet 175, U.S. Forest Service, titled Eastern Larch Beetle by Seybold, S.J., M. Albers and S. Katovich, ELB outbreaks have been extensive throughout North America since the 1970s. In Minnesota, tamarack mortality has been mapped on 162,000 acres (10 percent of their tamarack resource) in the last 10 years, with no signs of population collapse.

Signs of ELB attack include resin flow on the bark during summer months, and yellowing foliage starting at the bottom of the tree in mid- to late summer. Tree tops often remain green into the fall prior to fall color, making aerial detection of affected stands difficult or impossible. These trees fail to leaf out the following spring. In the fall and winter, woodpeckers often remove the bark as they feed on ELB.

Stress often triggers ELB outbreaks. Defoliation is most often cited as a causal factor. Other stresses triggering ELB populations include flooding, drought and storm damage.

Once ELB becomes epidemic, there is no relation between ELB impacts and stand age, upland versus lowland, or stand size. However, as older stands continue to age, they become more susceptible. Tamarack is shade intolerant, so stress from competing trees and vegetation can be a factor in well-stocked stands.

ELB builds populations in wind-thrown trees, log piles, snow breakage and logging debris. Periodically cutting and removing dead and dying trees helps reduce ELB numbers.

Management guidance is to harvest mature tamarack when rotation age has been attained, and to harvest tamarack stands if edge trees show signs of ELB activity. Once ELB becomes established, it quickly moves throughout the stand. Again, impacts are not generally seen until the following spring, when trees fail to leaf out. Thus, prompt action is important if trees are to be harvested while still valuable for fiber and lumber.

Tamarack killed by the eastern larch beetle.

Lecanium Scale

It is not unusual to find Lecanium scales on oaks and maples. Occasionally, high scale populations reduce tree vigor enough to cause branch mortality. Landscape or ornamental trees are most commonly affected.

Scales typically infest smaller branches and twigs during the spring and early summer. Eggs are produced underneath the female in late spring. Eggs hatch in early summer and the immature insects seek feeding sites on the underside of leaves.

In late summer, they migrate to twigs where they overwinter. Insect parasites and predators are normally effective in controlling infestations. Insecticides targeting immature scales in early-to mid-summer are effective.

Lecanium scale on a maple branch.

Weather Impact

A Cool Wet Spring: My Trees Don't Look So Good…

After suffering through two years of extremely cold winters in 2013 and 2014, many areas of Michigan were lambasted by a hard, late-spring frost in May 2015. Many newly developing oak leaves were killed by this late frost. Oak canopies with heavy leaf loss developed new leaves by late in June. This killing frost was followed by unseasonably cool, wet weather through much of June. As a result, maple and oak tree leaves were subject to attack by leaf fungi. The most common leaf blight was caused by *Anthracnose* fungi.

Anthracnose

Anthracnose diseases of hardwood trees are widespread throughout the eastern United States. The most common symptom of these diseases is dead areas or blotches on the leaves. Because of the blackened and scorched appearance of the leaves, these diseases are often called leaf blights.

Symptoms vary somewhat, depending on the host. Under certain conditions, the whole leaf dies and falls prematurely. On some tree species, the diseases may also damage twigs, shoots, buds and fruits.

Anthracnose fungi attack numerous hardwood species, including ash, basswood, birch, elm, hickory, horsechestnut, maple, oak and sycamore. The diseases are particularly severe on American sycamore, white oak and other oaks in the white oak group, as well as black walnut.

Sometimes, these species can be almost completely defoliated. Red oaks appear to be less susceptible than the white oaks.

Symptoms on infected leaves range from tiny dead spots to large

Oak Anthracnose.

circular or irregular dead blotches, depending on the tree species. Dead areas are black, brown or purple. Infection in the early spring may turn the leaves black so that they resemble leaves damaged by frost. If they are not killed by the fungi, young leaves may become distorted by the unequal growth in healthy and infected parts. Distorted leaves are common on oaks.

When severely infected, trees may lose their leaves. If this defoliation occurs in spring or early summer, a tree will usually produce a second crop of leaves later in the growing season.

Weather Impact *continued*

Oaks

White oaks in areas affected by frost and unseasonably wet, cool weather in June were especially hard hit by *Anthracnose* fungi. Samples from these trees were sent to Dr. Jill D. Pokorny, Plant Pathologist, U.S. Forest Service, Northeastern Area, State & Private Forestry, Forest Health Protection in St. Paul, Minnesota. Her response follows:

> *This is the shoot blight phase of* Anthracnose. *We do not often see the shoot blight phase of anthracnose. Usually, we see only the leaf blight phase. But, with the recent weather shift to more rain in the early spring, leafspot diseases have been occurring for many years in succession. Disease severity has increased due to a buildup in inoculum levels, and more severe symptoms of shoot blight are manifesting. White oaks are highly susceptible to anthracnose.*
>
> *With this shoot blight phase, we are seeing some leaves that are infected first via the petioles as the fungus spreads from twig cankers and moves from the base of leaf petioles. Leaves with damaged petioles that were infected with the anthracnose fungus, have petioles that are leathery and tough. The petiole-infected leaves had the water and nutrient supply cut off by the fungal infection and they turned a generalized off-color as they declined.*

Maples

Leaf blight of maples caused by *Anthracnose* fungi was also widely reported. In addition, maple tar spot (*Rhytisma* spp.) was prevalent again in areas affected for the last few years. This is a blight of varieties of Norway maples, including Crimson King and Schwedler maple. Beginning in late July or August, patches of raised black areas on the upper leaf surface of Norway maples begin appearing. These spots darken and grow in size as the season progresses.

Trees infected with the tar spot fungus typically drop their leaves earlier than normal in the fall. Tar spots on infected leaves produce spores that will infect new leaves next spring if weather conditions are favorable. Maple tar spot infections occur most commonly in years when spring weather is cool and wet.

Fortunately, this leaf disease causes little damage to trees. However, in some areas where tar spot has been heavily for three to four years, some mortality of small branches indicative of a decline in tree vigor appeared in 2015.

Maple tar spot.

Forest Health Cooperator Reports

Protecting the health of Michigan's forests is a challenging task. Universities, state and federal agencies work in partnership to ensure that research and detection activities are effective and timely.

Michigan Department of Agriculture and Rural Development

Hemlock Woolly Adelgid

Hemlock woolly adelgid (HWA) was detected on four properties in Ottawa and two properties in Muskegon County in 2015. These were the first locations in which HWA has been found infesting native forest hemlock in Michigan. There are no known established populations of HWA anywhere else in Michigan. Past and present HWA infestations in Michigan have been reported by landscapers, arborists, and other alert citizens knowledgeable about HWA and its potential impacts.

Hemlock woolly adelgid-infested hemlock branch in Ottawa County, Michigan. Photo courtesy of MDARD.

Prior to 2015, HWA had been found infesting landscape hemlock in Emmet (2006, 2007, 2010), Macomb (2010 - two locations), Ottawa (2010 - two locations), Berrien (2012) and Allegan (2013) counties. Eradication efforts were initiated at each of the locations the year they were detected. To date, surveys indicate no evidence that HWA persists at any of these locations.

So far, no clear source of the infestations has been found. It is likely that hemlock nursery stock was brought to Michigan from infested areas of the country either prior to, or in violation of, the Michigan Department of Agriculture and Rural Development's (MDARD) Hemlock Woolly Adelgid Quarantine was implemented in 2002. The quarantine restricts the movement of hemlock into the state, and includes a ban on movement of hemlock into the state from infested areas.

Delimit survey work has begun at the locations detected in 2015. In Ottawa County, infested trees at three of the four properties have been treated. In Muskegon County, infested trees at one of the two properties have been treated. Plans are being made to treat infested trees at additional locations in 2016. Treatments consisted of a soil-injected application of dinotefuran. Samples collected in early November from the treated trees, and analyzed by MSU Entomology Department staff, indicated that treatments were very effective.

Samples of the HWA in Muskegon County were collected and sent to the U.S. Forest Service for genetic testing in an attempt to determine if they are eastern North American clones, or whether they could be an introduction from western North America. This information will help MDARD refine and improve its HWA regulatory activities.

A HWA response group with representation from MDARD/ Pesticide and Plant Pest Management Division, MSU Entomology Department and Michigan Department of Natural Resources Forest Resource Division has been working to development a HWA assessment plan. The assessment plan will be used to inform those from which funds to increase and continue response activities are being sought. Activities at the infestation sites have been supported in part by a Forest Health Protection grant from the U.S. Forest Service.

Michigan Department of Agriculture and Rural Development *continued*

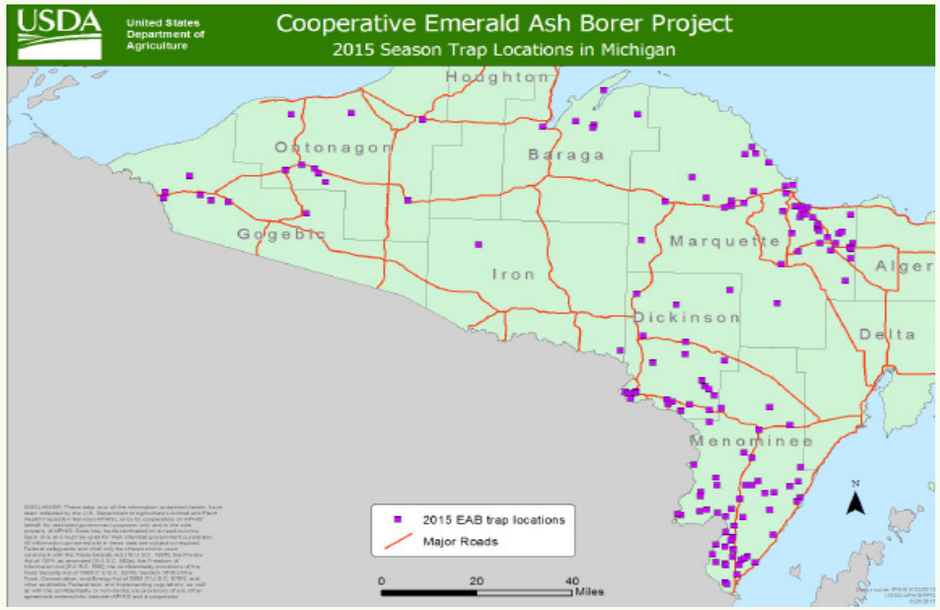
Emerald Ash Borer

In 2015, the United States Department of Agriculture - Animal and Plant Health Inspection Service deployed 142 purple panel traps baited with (Z)-3-hexanol in the Upper Peninsula counties of Baraga, Dickinson, Gogebic, Iron, Marquette, Menominee and Ontonagon.

Since 2012, emerald ash borer (EAB) trap placement has been based on a survey sampling design developed in collaboration between the APHIS EAB Program and the USFS Health Technology Enterprise Team.

Survey results will be announced in early 2016. If a revision to the State's internal EAB quarantine is needed due to trapping results that will take place in early 2016 as well.

Michigan Department of Agriculture and Rural Development (MDARD) staff continued to renew and issue intra-state compliance agreements as necessary. MDARD maintains approximately 125 compliance agreements with receivers, brokers and shippers. A majority of these entities are in the UP or otherwise involved with the intrastate movement of regulated materials into or within the UP. MDARD staff continued to conduct compliance inspections with EAB compliance agreement holders and write phytosanitary certificates for ash logs and lumber being shipped internationally. The movement of any article regulated by the EAB Quarantine from the Lower Peninsula (L.P) to the U.P. continues to be prohibited, except with a current and valid Compliance Agreement.



For more information about EAB visit www.emeraldashborer.info or visit the MDARD EAB website at www.michigan.gov/eab.

Michigan State University

Do I Have to Treat My Ash Trees Forever?

Long-term Evaluation of Imidacloprid and Dinotefuran Used to Protect Ash Trees from Emerald Ash Borer

Andrew Tluzcek and Deborah McCullough

Back in spring 2006, we selected 32 small white ash trees (*Fraxinus americana*) growing in a field at Seven Lakes State Recreation Area in Oakland County. In 2006, emerald ash borer (EAB) populations were building in the area. These white ash trees appeared healthy but other ash trees in the area, especially the green ash (*F.* pennsylvanica), were beginning to decline and nearly all were dead by 2010 or 2011.

The 32 white ash trees were randomly assigned to be treated with one of the following means:

- Imicide® applied as a trunk injection with Mauget® capsules (imidacloprid).
- A basal bark spray of Merit® (imidacloprid).
- A basal bark spray of Safari® (dinotefuran).
- Left untreated as a control.

We returned to the site and re-treated the trees in late May or early June every year from 2006 to 2012.

Each summer, we collected leaves from all of the trees. We recorded survival of adult EAB beetles caged with leaves from each tree and collaborated with other scientists to quantify insecticide residues in the leaves of the trees. We also monitored the condition of the trees in mid-summer. Every fall, we recorded the number of EAB exit holes, woodpecker holes (where the birds preyed on an EAB larva), along with bark cracks over galleries and other variables. The sum of the new exit holes and woodpecker holes indicate the number of EAB that successfully developed that year. The holes are stapled to ensure they are not re-counted in subsequent years. We have not treated the trees since 2012, but we have continued to monitor their condition and count EAB exit holes and woodpecker holes.

Exit holes left by emerging EAB beetles and woodpecker holes peaked in 2008. On average, there were 14 to 27 EAB exits/woodpecker holes per m^2 of surface area on treated trees and 53 per m^2 on the surviving control trees. By 2010, 10 of the 32 trees had died, including five of the untreated controls and one or two trees in each insecticide treatment.

Beginning in 2011, however, the EAB population in the area dropped substantially. We found very few new exits or woodpecks on any trees in 2011 or 2012, which led to our decision to stop applying the insecticides. Residues in the foliage of treated trees declined rapidly and were generally undetectable in 2013.

The number of EAB exits or woodpecks has remained very low since then. On average, we found less than two exits/woodpecker holes per m^2 in 2013, 2014 and 2015. Trees that had been attacked by EAB in between 2006 and 2010 appear to be recovering.

Canopies look good and trees are growing well. While EAB is clearly present in the area, the local EAB population is not high enough to overwhelm and kill trees. Our previous studies have shown EAB beetles prefer green ash over white ash. Given the lack of live green ash trees in this area, it seems likely that the white ash trees have effectively survived the EAB invasion.

Michigan State University *continued*

Can systemic insecticides protect against beech bark disease?

James B. Wieferich & Deborah G. McCullough

High-value American beech (*Fagus grandifolia*) trees in residential and urban landscapes, as well as forested areas, are threatened by beech bark disease. Beech bark disease begins when tiny, non-native beech scale insects colonize the trunk and branches of beech trees. The scales secrete white wax as they feed and heavily infested trees appear to have "wool" on the bark. Wounds created when the sap-feeding scale insects pierce the bark enable a non-native Neonectria fungus to infect the tree. The fungus kills patches of inner bark (phloem) and cambium, causing branches and eventually the entire tree to die. Several studies have evaluated beech bark disease impacts in forests and silvicultural guidelines were developed for northern hardwood forest types. There are, however, virtually no effective options for controlling beech scale and protecting valuable beech trees in landscape settings.

We are currently evaluating potential options to control beech scale. An insecticide sold as TreeAzin® (azidirachtin) is applied by injecting the product into the base of the trunk, then allowing the tree to transport the insecticide in the xylem tissue up the trunk and into the branches. Another insecticide sold as Safari (dinotefuran) can be applied by spraying the lower 4 to 5 feet of the trunk. Because this product is highly soluble, the insecticide can move through the outer bark and into the xylem without requiring injection.

We are also evaluating a different kind of product called Pentra Bark. This is not an insecticide but is simply a soapy detergent sometimes used as a surfactant with insecticide or fungicide applications. If

Dr. Deborah McCullough, Michigan State University professor, injects an infested beech tree with TreeAzin.

the Pentra Bark breaks down the wax secreted by the beech scale insects, it could effectively provide a non-toxic means to control the insects. In addition, we will monitor aspects of the life history of beech scale, including egg production, hatch rates, development and survival of scale life stages. Collaborators, Dr. Jean Berube (CFS)

Michigan State University *continued*

and Dr. Richard Wilson (OMNR), attempted to develop molecular markers to detect presence of Neonectria spp. in bark/phloem samples and determine whether the presence or abundance of beech scale correlates with presence of Neonectria spp. mycelium with little success.

To evaluate the products, we selected 36-48 trees in each of three sites in Mason County in June and early July. Insecticides were applied at different times during the summer, to target either the mature female scales or to target young, immature scales just beginning to feed. To estimate beech scale density and survival on, we collected bark punches and took digital images of 15x15 cm areas on opposite sides of the trunk of each tree. We can examine bark punches under a microscope to count live and dead scales, monitor reproduction and assess egg hatch. Digital images of bark are processed using software that records the area of the image covered by scale wax. We can then estimate scale density per cm^2 of bark using a simple linear regression we developed a few years ago. Effectiveness of the treatments will be determined next summer when we re-sample the trees and compare beech scale density on treated and untreated trees.

Left: *Applying an insecticide treatment to the trunk of a beech scale-infested tree.* ***Above:*** *Following treatments, bark samples collected with an arch punch are used to measure beech scale density and survival.*

Michigan State University *continued*

Evaluating Trap Designs for EAB Detection

Deborah G. McCullough & James B. Wieferich

Effective methods to detect and monitor populations of emerald ash borer (EAB) remain a critical aspect of managing this invasive pest across much of the U.S. External symptoms of infestation such as bark cracks, D-shaped exit holes left by emerged adults and declining canopies are not apparent until larval densities build to moderate or high levels. Adult beetles do not produce long-range pheromones, but use visual stimuli and volatiles to locate host trees, where they also are likely to find potential mates. In general, male beetles are attracted to specific shades of green while female beetles are more attracted to shades of purple. Beetles are also attracted to light. For example, trees in full sunlight will be colonized sooner and at high densities than similar trees that are shaded.

Double decker emerald ash borer trap with a green and purple prism.

In 2015, we continued our efforts to determine whether artificial traps for EAB detection methods can be improved. Double-decker (DD) traps consist of two plastic coroplast prisms (each 16 x 25 inches) covered with clear Pestick. One prism is zip tied to the top of a 10-feet-tall PVC pipe (4 inches in diameter) and the second prism is similarly attached halfway down the pipe. The PVC slides over and is supported by a T post. Lures to attract EAB are attached to the lower edge of each prism. The DD traps are placed in full sun, usually 15 to 30 feet from ash trees along the edge of a wooded area. This trap design incorporates both visual cues (color, sun) and olfactory cues (volatile compounds in the lures) to attract EAB beetles.
Studies in 2015 included collaborating with U.S. Forest Service researchers to compare "standard" DD traps with two dark purple prisms to DD traps with green prisms on top and a lighter shade of purple on the bottom. The green-light purple DD traps captured more EAB overall than the DDs with two dark purple prisms. Sex ratios of EAB captured on the green-purple traps, however, were highly male-biased, while the dark purple prisms captured a higher proportion of females. This is potentially interesting given that mature female EAB are able to fly farther than males and, if mated, can initiate new infestations. We also assessed inexpensive methods to increase EAB attraction to DD traps. Small "disco" balls or mirrors to reflect sunlight onto the panels were evaluated but did little to improve EAB captures.

We continued to collaborate with several other scientists to evaluate different lures and trap designs. Our portion of the project involved setting up four blocks of traps in each of two sites with low EAB densities in the eastern Upper Peninsula. Each block included a standard DD trap and a green-light purple DD trap, one purple canopy trap distributed by U.S. Department of Agriculture Animal and Plant Health Inspection Service for the national EAB detection survey, a dark green canopy trap used in Canada and a green funnel trap. All traps were baited with a cis-3-hexenol lures and the green canopy trap was also baited with cis-lactone, a short range EAB pheromone. Similar designs were set up in sites in Ontario, Pennsylvania and Ohio. Data analysis is underway.

Michigan State University *continued*

2015 Michigan Exotic Forest Pest Survey

Sara R. Tanis and Deborah G. McCullough

We cooperated with the Michigan Department of Agriculture & Rural Development (MDARD), the Michigan Department of Natural Resources and U.S. Department of Agriculture Animal and Plant Health Inspection Service to survey more than 60 different sites for invasive forest pests not yet known to be established in the U.S. or in Michigan.

Sixteen insect species were targeted for this survey, including bark beetles, woodborers, and defoliators that feed on the leaves or needles of a wide range of trees. Several types of insect traps were used in the survey. Funnel traps and cross vane traps were set up to trap bark beetles and woodborers, while wing traps, delta traps and milk carton traps were used for moths. Each trap was baited with a pheromone lure to attract a specific pest species or with volatile compounds produced by the host trees of the target insect.

We selected 28 recreational sites based on potential invasion pathways commonly associated with the movement of firewood, nursery or landscape trees, and logs. Sites included state parks and recreation areas, sawmills, and tree nurseries. To select sites for trapping, we compiled risk maps for the Upper and Lower peninsulas using spatial data layers, point data and derived coverages in a GIS, then weighted the factors to prioritize trapping sites. Variables included forest cover type, state park visitor data, and sawmill, campground, railroad and highway data. For example, Tahquamenon Falls State Park is surrounded by maple-dominated forest and is considered a high-risk site because the park attracts visitors from zip codes where Asian longhorned beetle is present.

We also surveyed 34 industrial sites where automotive parts, large quantities of steel, or other metals or plastics are imported. Such commodities often arrive with pallets, wood crating and similar items known to vector wood and phloem-feeding insects. Other high-risk industrial sites included companies that produce or use large amounts of unprocessed wood, along with rail yards, airports with frequent cargo flights, and landfills that accept commercial or industrial waste.

Permits or permission to deploy traps were acquired for all sites. Traps were set up and baited in May and June to ensure they were present when target pests would likely be active. We collected insects from the traps every two to four weeks and replaced lures as needed throughout the summer. Insects collected in the traps are stored in a freezer until they can be sorted, pinned and identified. Because many native insects are attracted to, and captured by the traps, sorting and identification is a laborious process. We began this part of the work in July and hope to complete identifications in January 2016. Personnel from MSU will identify the longhorned beetles, metallic woodborers and horntails, while MDARD personnel will identify weevils and bark beetles. Happily, we have not found any of the forest pests targeted in the survey so far and we hope that will continue to be the case.

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White Ash Survival in Forested Sites in the Core of the Emerald Ash Borer Invasion

Molly Robinett and Dr. Deborah McCullough
Dept. of Forestry & Dept. of Entomology, Michigan State University,
East Lansing, Michigan

Since its discovery in 2002 in the Detroit Metro area, emerald ash borer (EAB) (*Agrilus planipennis* Fairmaire) has caused catastrophic levels of ash mortality. In previous studies, scientists from MSU, Ohio State University and the U.S. Forest Service reported greater than 99 percent of the white ash (*Fraxinus americana* L.), green ash (*F. pennsylvanica* Marsh.) and black ash (*F. nigra* Marsh.) in plots in southeast Michigan and Ohio were killed by this destructive pest. These reports have led forest managers across the U.S. and Canada to assume that ash are effectively doomed once EAB arrives. We have observed, however, an unexpectedly high proportion of overstory white ash trees remain alive in some sites in southeast Michigan, despite the presence of EAB in these areas for 10 years or more.

In 2014, we surveyed more than 40 large forested parks, game areas and recreation areas across southeast and central Michigan. We found 28 sites where white ash, living and dead, were abundant. Within each site, we established a center point in the midst of the white ash. We then inventoried forested land using variable radius plots to document the species, diameter (DBH) and canopy condition of overstory trees (greater than or equal to 6 centimeters DBH) within a 1.5 kilometer radius.

We more intensively surveyed a 1 hectare area where white ash trees were most abundant at each of the 28 sites. White ash and other overstory trees (greater than or equal to 6 centimeters) were counted, measured and canopy condition assessed in four fixed

Molly Robinett prepares to measure diameter at breast height (DBH) of a healthy white ash tree.

radius macroplots (18 m). Regeneration (seedlings, saplings and recruits) of all species were also documented. We then calculated the proportion of white ash trees that are alive and dead overall and by dbh class for each site.

We recorded a total of 2,546 white ash trees across the 28 sites. White ash survival rates within sites range from less than 5 percent to more than 90 percent of the trees. Overall, 74 percent of the white ash are alive and nearly all (96 percent) are healthy with less than 50 percent canopy dieback or thinning. We monitored EAB population levels in both 2014 and 2015 using two double-decker (DD) traps consisting of two purple or green prisms attached to a 3 meter tall PVC pipe and baited with cis-3-hexenol and Manuka oil. Similar

Michigan State University *continued*

numbers of EAB were captured in 2014 and 2015, with numbers ranging from less than five to 64 EAB in individual sites.

Our results to date indicate EAB populations persist in all sites. There are sites where nearly all white ash have been killed, but there are more areas where most of the white ash remain alive and relatively healthy. Trees are recovering from past EAB attacks; we often see new wood and bark laid over old EAB larval galleries. Populations of EAB seem unlikely to build to densities associated with the catastrophic white ash mortality levels recorded in other areas. We are currently analyzing site-related variables, surrounding vegetation, presence of corridors and land-use categories using a GIS to determine if specific factors are consistently associated with high or very low white ash survival rates. If so, then we should be able to test a model and assess our ability to predict the likelihood of white ash survival in areas that are not yet infested with EAB.

Michigan State University *continued*

Michigan Eyes on the Forest and Sentinel Tree Network

Deborah G. McCullough, Manuel Colunga-Garcia, Amos Ziegler, Russell Kidd, William Cook, Julie Crick, Georgia Peterson and Michael Schira

Dept. of Entomology, Dept. of Forestry, Center for Global Change & Earth Obs., Michigan State University and MSU Extension

Michigan forests have dealt with more than their fair share of invasive insect and pathogen pests. This is not a new phenomenon – white pine blister rust, for example, was present in Michigan by 1917. More recent invaders include Dutch elm disease, gypsy moth, several European sawflies, pine shoot beetle, along with beech scale and beech bark disease. The worst of the worst, emerald ash borer, got its start in Michigan and has become the most destructive forest insect to ever invade North America. In fact, at least 49 of the 62 "high impact" invasive forest pests in the U.S. are well-established in Michigan. Effects of these unwanted alien insects and pathogens include substantial economic costs and sometimes profound changes in native forest ecosystems. A recent study showed economic costs of invasive forest insects in the U.S. exceed $4 billion annually. These costs, largely borne by municipal governments and homeowners, do not include the cascading ecological effects on other plants, animals and ecosystem services.

Unfortunately, things could get worse. Major pests, including Asian longhorned beetle (ALB) which attacks maples and several other trees, hemlock woolly adelgid (HWA), and thousand cankers disease (TCD) of walnut are present in other northeastern states as well as Ontario. These invasive pests could cause substantial damage if they spread through Michigan. Thanks to a recent grant from the Michigan Invasive Species Grant Program, MSU scientists, MSU Extension foresters and Conservation District foresters have launched a statewide effort to build awareness about the risks of these and other unwanted forest pests and to increase the likelihood of early detection if a new invasive forest pests become established.

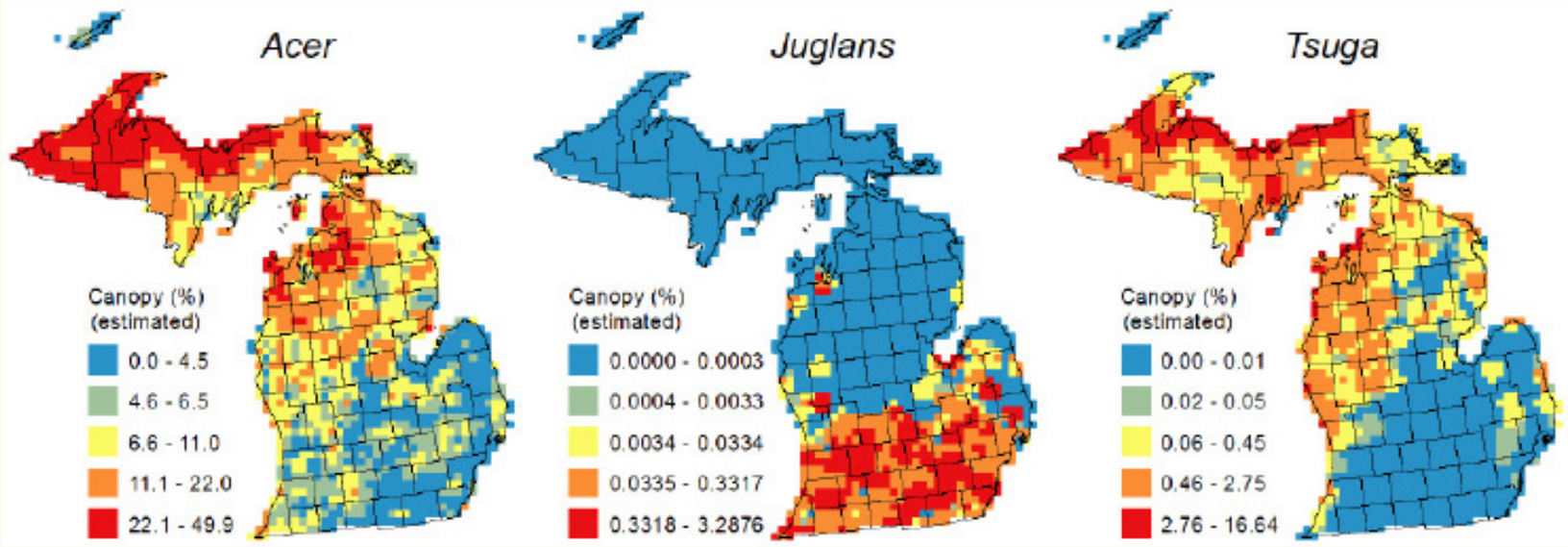
The multi-faceted project, "Eyes on the Forest: Invasive Forest Pest Risk Assessment, Communication and Outreach", involves modeling to assess likely invasion pathways and mapping to identify relative risks of establishment of ALB, HWA and TCD.

Several MSU Extension and Conservation District foresters are providing information on the three "target" pests and forest invasives in general to a wide range of groups and property owners. Communication is facilitated by the Midwest Invasive Species Information Network (MISIN) website, housed at MSU.

A unique aspect of this project involves creating a "Sentinel Tree Network" across Michigan. Volunteers agree to "adopt" an individual tree, then periodically monitor and report on the condition of that tree two or three times a year. As this network expands, more "eyes" will be looking at trees for unusual signs or symptoms that may indicate a new invasive pest. Sentinel Tree volunteers do not need to be professional foresters or arborists, but they should have enough expertise to identify the species of their tree, measure its diameter and assess its general condition. Volunteers then submit information about their tree through the on-line MISIN website.

Michigan State University *continued*

The Sentinel Trees will provide a record of individual tree health across a sizeable expanse and over time, supplementing scientific and regulatory surveys. To date, at least 100 people have volunteered to adopt a Sentinel Tree and we hope many more people will join this effort. To volunteer or to request more information, contact Russell Kidd, Eyes on the Forest outreach coordinator at kidd@msu.edu.



Maple **Walnut** **Hemlock**

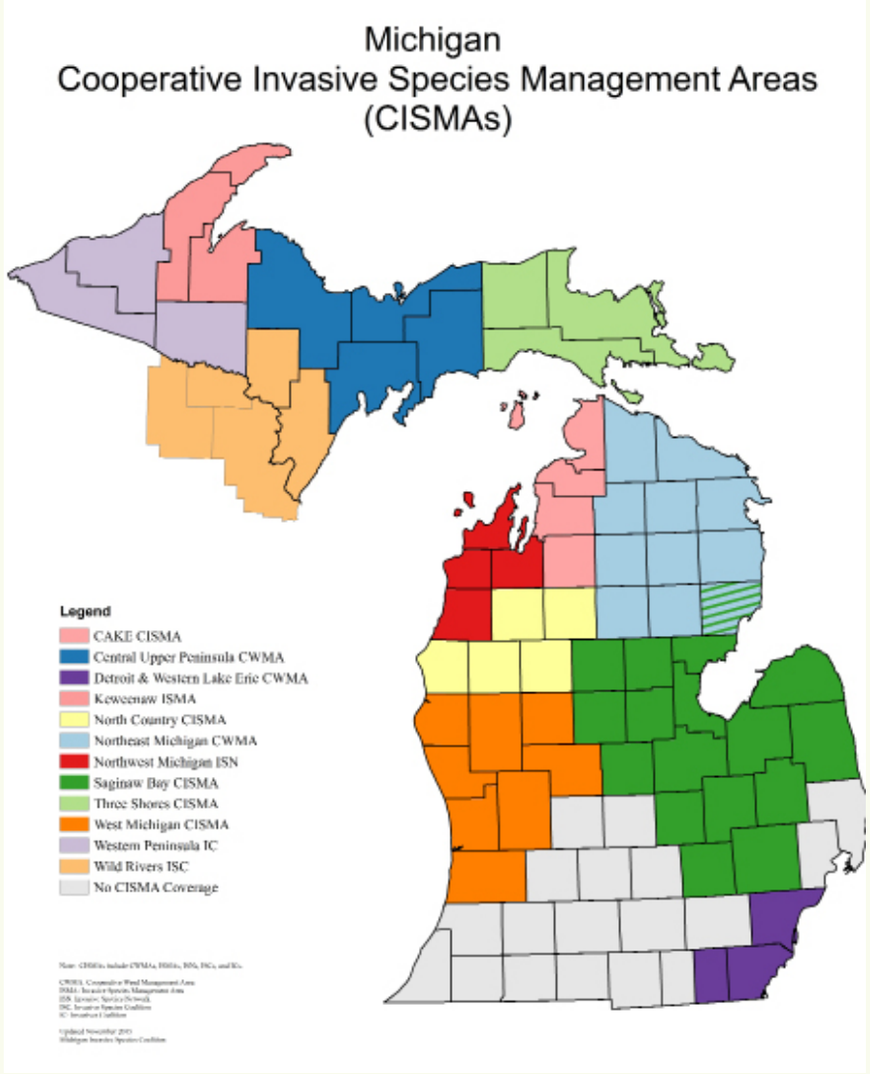
Cooperative Invasive Species Management Areas

In 2015, Michigan's Invasive Species Grant Program (MISGP) devoted funds to invasive species management across the state. One of the focus areas of this program was to fund the creation and empowerment of regional collaborations to more effectively manage invasive species. These collaborations, termed Cooperative Invasive Species Management Areas (CISMA), have a diverse membership and contribute to all aspects of invasive species management.

The boundaries and membership of each CISMA are truly unique. CISMAs are grass-roots movements that come together to pool resources, overcome political boundaries and increase organization within important ecological boundaries. Their steering committees and membership are made up of local volunteers passionate about invasive species management. They represent a diverse group of entities and jurisdictions.

CISMAs recognize that invasive species issues in neighboring jurisdictions often spread and become everyone's problem. In many cases, local, state and federal agencies and nonprofit organizations are willing to coordinate and contribute resources where partnerships have not existed in the past. For example, invasive species management efforts on national and state forest land are collaborating with local CISMAs to ensure that eradication efforts are not thwarted by invasive populations on adjacent lands.

CISMA activities can be loosely grouped into four main areas: outreach and education; prevention; early detection and response; and treatment of infestations. Some Michigan residents may only hear about invasive species when they appear on television or the



Cooperative Invasive Species Management Areas *continued*

front page of a newspaper. CISMAs have been an effective local resource for educating people on invasive species issues as well as promoting active participation in management efforts.

CISMAs are able to focus on current and future invasive species of greatest relevance to their local area. Their outreach efforts also serve to emphasize the importance of prevention, which remains the most efficient and effective means of invasive species management.

In addition to outreach efforts, CISMAs serve to map new and existing invasive species infestations within their boundaries. CISMA members and engaged citizens help to map invasive species occurrences using a centralized reporting and mapping system, the Midwest Invasive Species Information Network (www.misin.msu.edu). This network alerts managers to new infestations and is an integral part of the early detection and response strategy. When new infestations are detected, CISMA resources can be used to respond with appropriate treatment. These resources range from MISGP grant funds to coordination of volunteer efforts. Whatever decisions are ultimately made, the process is a collaborative effort made by the people of the CISMA.

CISMAs currently cover 65 of the 83 counties in Michigan. Ideally, every county in Michigan will be part of a CISMA in the near future. The DNR is taking steps to encourage and facilitate reaching this goal.

To learn more about your local CISMA, or ways to get involved, please visit www.Michiganinvasives.org.

Northwest Michigan Invasive Species Network volunteers, in partnership with the Frankfort Tree Board, remove garlic mustard from Tank Hill in Benzie County, Michigan.

Grand Traverse Conservation District Employees and SEEDS crew members work together to install a boot brush station at Historic Barns Park in Traverse City Commons. Patrons use this station to clean seeds, mud, and other plant material from their boots, in order to prevent them from spreading invasive plants.

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