Wisconsin DNR Forest Health 2017 Annual Report

Spruce needle rust.
Photo by Linda Williams

WISCONSIN
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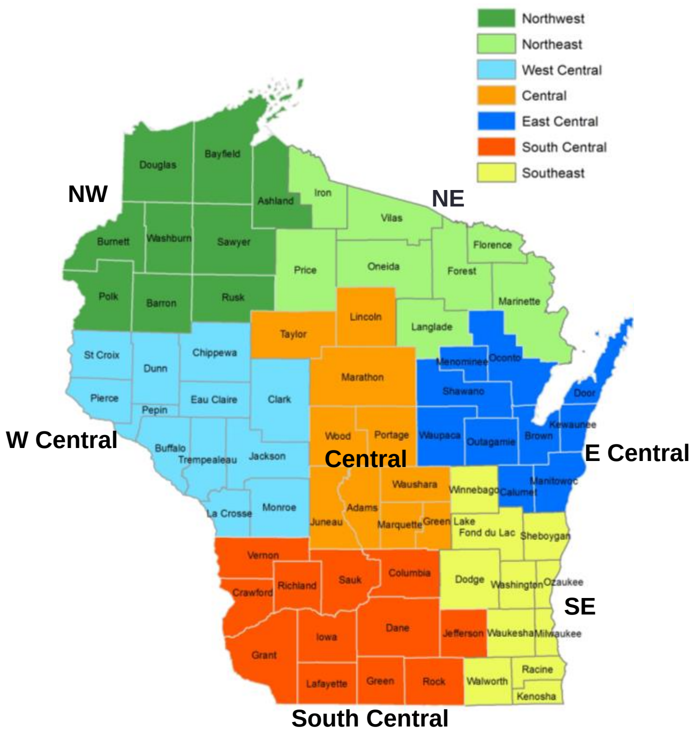
Wisconsin DNR Forest Health Staff



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Staff Update

After 10 years as the forest health outreach and education specialist, **Colleen Robinson** was hired by the Forest Stewards Guild to be the communications coordinator for this national, nonprofit organization. We were sad to see her go but thrilled that she has this opportunity to take her talents to the national stage in a permanent position. We also look forward to continued work with her on cooperative projects between the department and the Guild

Colton Meinecke joined the forest health team in 2016 after completing his undergraduate degree in microbiology at UW Madison. He brought to the pathology lab a deep knowledge in molecular diagnostics, raising the capability of the lab in these modern techniques. In June 2017, Colton took a permanent position as a microbiologist for the West Virginia Department of Public Health in their Office of Laboratory Services. We will miss him and his mad skills and wish him the best of luck in his new job.

Josh Haberstroh joined the forest health team on May 30, 2017. Josh's duties include managing and processing all forest pathogen samples sent to the lab as well as assisting with field work. He is a recent graduate of UW-Madison with a B.S. in Biology. Josh is a private pilot who goes on frequent adventures with his fiancé, Elizabeth. He also enjoys hiking, fishing, and gardening. Josh's attention to detail and cheerful, "can do!" attitude make him a great addition to the team.

Jodie Ellis joined the forest health team in October 2017 after moving to the Madison area from Boise, Idaho, where she worked for the Idaho state government as an entomologist and later as the executive director of the Board of Veterinary Medicine. Before moving to Idaho, Jodie worked as the Invasive Insects Education Coordinator at Purdue University for nine years, cutting her professional teeth on emerald ash borer. Although she has a tough act to follow as Colleen's replacement, she is optimistic that she will be able to hang in there.

The Forest Resource in Wisconsin

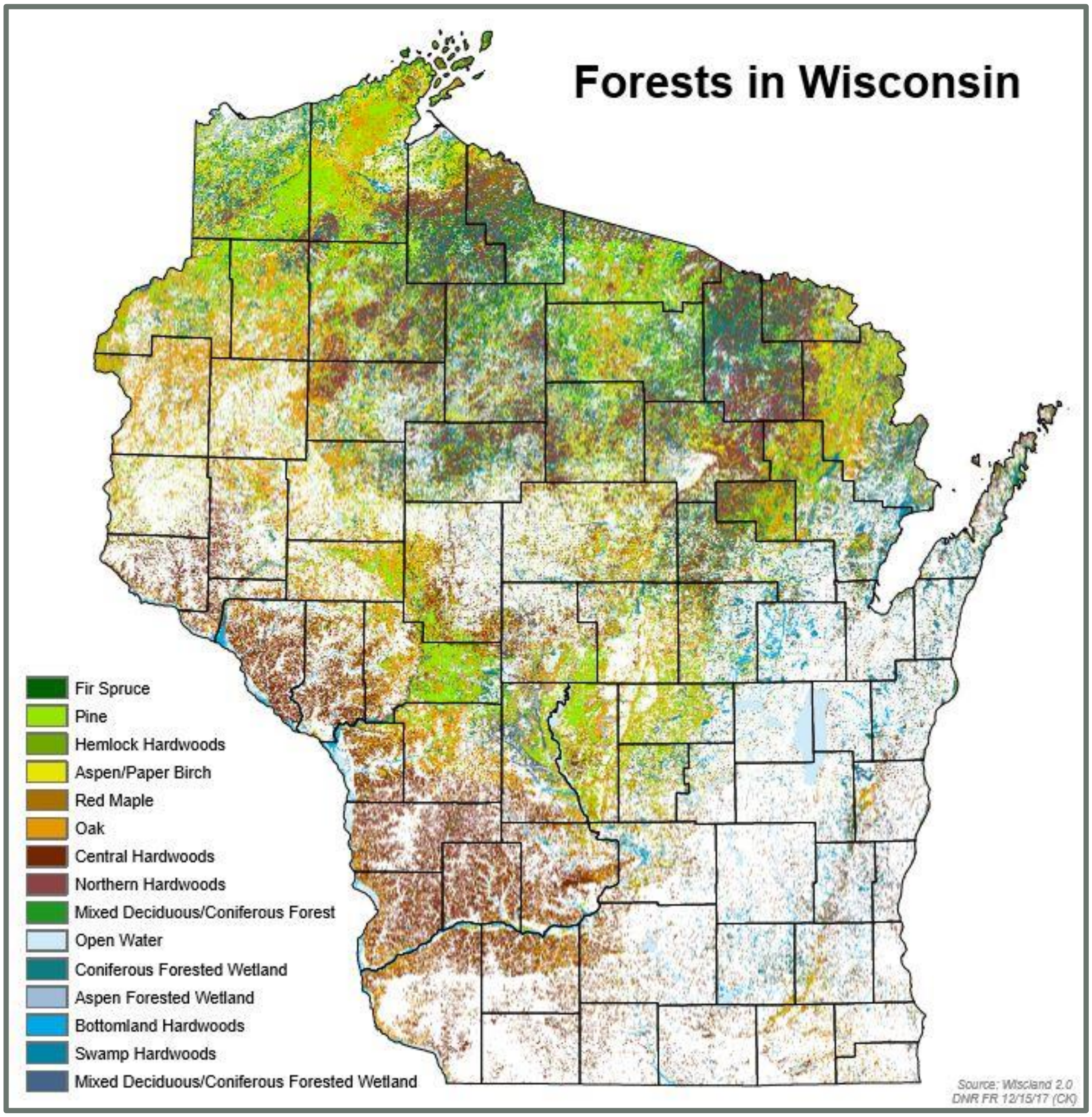


Figure 1. Wisconsin forest cover map. Source: WISCLAND land cover, Wisconsin Dept. of Natural Resources, 2017

Wisconsin's forests are critical for providing wildlife habitat, clean air and water, reducing erosion, and improving the quality of life in urban and rural areas. Forests are also important to the economy of Wisconsin for wood products, recreation and tourism. Current information on the forest resource in Wisconsin is available at dnr.wi.gov.

The area of forestland in Wisconsin has steadily increased in recent decades and currently stands at approximately 16.5 million acres (Figure 1). This is an increase of 1.8 million acres since 1983 and 845,000 acres since 1996. Wisconsin now has more forested area than at any time since the first forest inventory was conducted in 1936; over 46% of the state's land area is forested, primarily in the northern and western areas of the state.

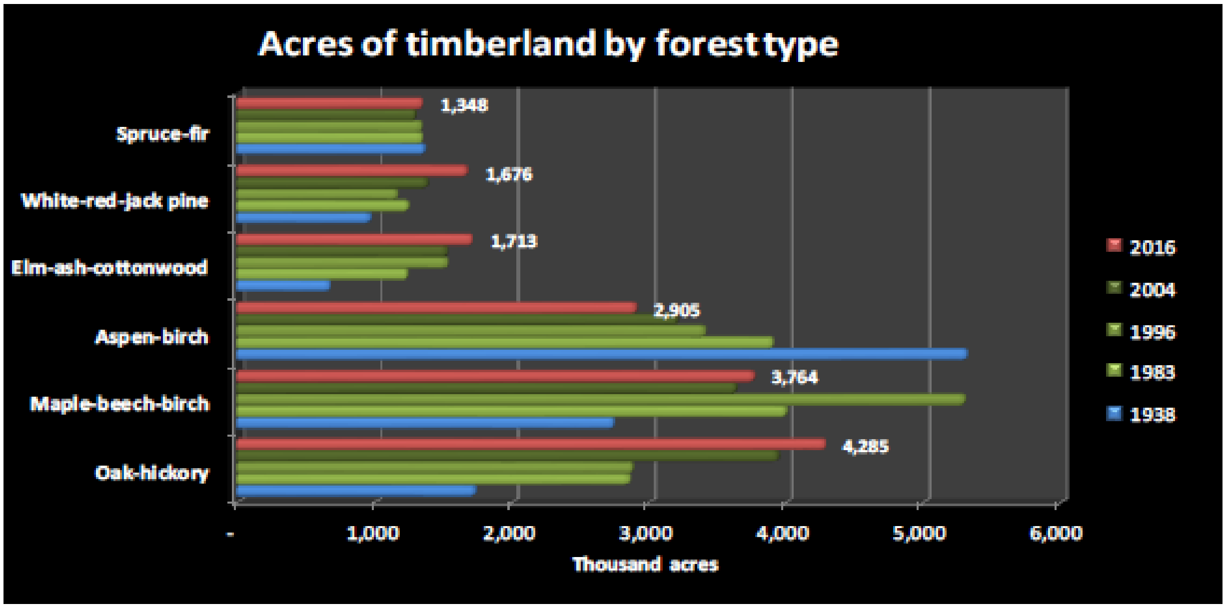


Figure 2. Wisconsin timberland area by forest type (FIA data, US Forest Service)

Wisconsin's forests are composed primarily of hardwood species. The most abundant forest types are oak-hickory at 27% of total forested acreage; maple-beech-birch at 23%; and aspen-birch at 19% (Figure 2). Conifer types, mainly pine and spruce-fir, represent about 19% of the forested area. Wisconsin forests are for the most part mature with the greatest proportion of stands in the 61-80 year class. About two-thirds of Wisconsin's forest lands are privately owned. The remaining third is split between federal, state, local government and tribal ownership.

Exotic Species Issues

Beech bark disease

Beech bark disease is a serious disease of American beech (*Fagus grandifolia*) in eastern North America. It is caused by a scale insect (beech scale, *Cryptococcus fagisuga*) and two fungi in the genus *Neonectria* (*N. faginata* and *N. ditissima*). In 2009, heavy infestations of beech scales and mortality of beech were detected for the first time in Wisconsin in Door County. Mortality from beech bark disease has been found only in Door County, although beech scale has spread through most of the range of American beech in Wisconsin (figure 3). In 2017, beech scale populations remained low across the range of American beech outside Door County in Wisconsin. Scattered beech, presumed to be infected with the disease, prematurely turned a golden yellow color in eastern Door County.

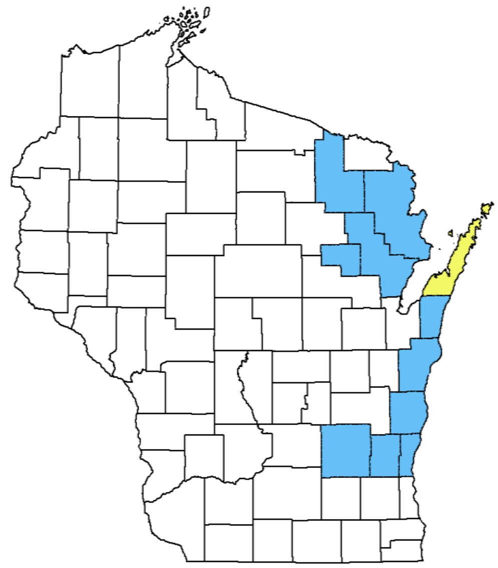


Figure 3. Counties with beech scale detections are shown in blue. Mortality from beech bark disease is limited to Door County (in yellow).

Confirmation of *Neonectria* sp. in scale infested beech

In the summer of 2017, perithecial (fruiting bodies) of *N. ditissima* were found on beech firewood cut and stored in the stand where heavy beech scale infestation was found in 2009 (Figure 4). This was the first confirmation of a *Neonectria* spp. on a beech tree in association with beech scale infestation and beech mortality in Wisconsin. The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), Plant Industry Lab, confirmed the fungal species through microscopic examination and molecular analysis. *Neonectria ditissima* is a native pathogen that attacks many species of hardwood forest trees.

Figure 4. *Neonectria ditissima* fruiting bodies found on beech firewood stored in shade. Photo by Kyoko Scanlon

Beech resistant to beech bark disease identified in Door County

Beech bark disease results from the effects of two components: feeding by non-native scale insects results in wounds then used by the *Neonectria* sp. fungi to enter and kill the beech. From 1 to 5% of American beech trees are resistant to the scale and are therefore not susceptible to beech bark disease. In 2016 and 2017, forest health staff tested three potentially scale-resistant trees as the first step in entering them into a breeding program for beech bark disease resistant American beech. The three candidate trees were each located in the beech stand where mortality from the disease complex was first encountered in 2009. Despite long exposure to high populations of scales on neighboring beech, these trees appeared free of the pest.

In the summer of 2016, the three candidate trees were challenged with 500 scale eggs placed on foam pads and sealed onto the bark with house wrap, forcing interaction of the scales with the tree. As a control, pads with scale eggs were also placed on cleaned sections of three nearby beech already infested with scale insects and thus known to be susceptible. One year later, forest heath staff inspected pads for the presence of scales on both candidate beech and control beech trees. They observed no life stage of the scale on the three candidate beech; all three control trees contained adult scales as well as egg clusters.

Scion wood was taken from the three resistant beech trees and sent to the U.S. Forest Service's Northern Research Station in Delaware, Ohio, where they were grafted. Grafted trees will be planted in the U.S. Forest Service's Oconto River Seed Orchard in Wisconsin. These trees will serve as part of a breeding program to develop a strain of non-native scale resistant beech, which will eventually be used to re-establish the species within its native range.

Jumping worms (*Amynthas* spp.)

Jumping worms were reported in 18 new Wisconsin counties in 2017 (Figure 5). These invasive worms have now been found in 40 of the state's 72 counties, primarily in urban and residential settings. Focused outreach resulting in increased public awareness likely accounts for the numerous reports.

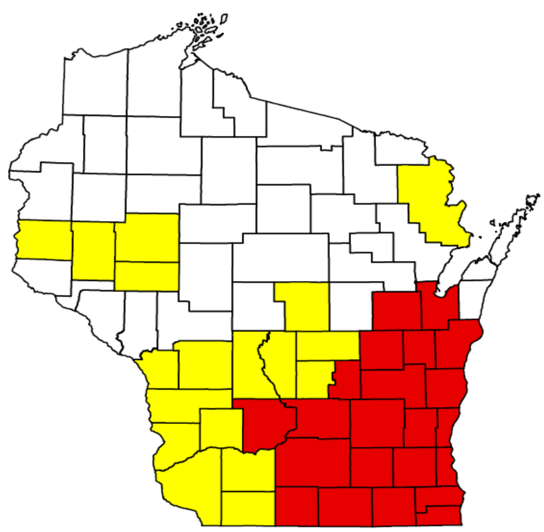


Figure 5. 2017 counties where *Amynthas* spp. have been confirmed. Counties tinted in yellow were confirmed in 2017; red counties were confirmed earlier.

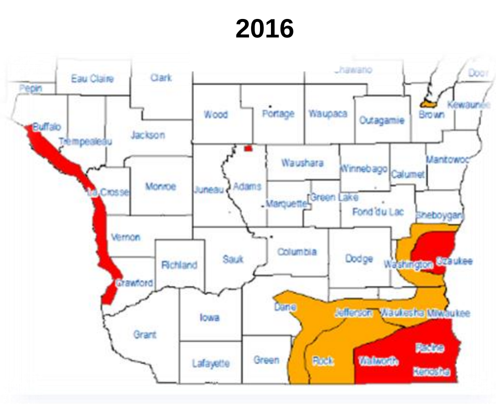
"Jumping worms" is a term used for a group of similar Asiatic worms with an annual lifecycle and voracious appetite for the upper organic layer of forest soils. Verified species in Wisconsin are *Amynthas tokioensis*, *A. agrestis*, and the closely related, though larger, *Metaphire* *hilgandorfi*, first identified in September 2017. *Amynthas tokioensis* is the most common of the three species.

Members of industry are informally trying to control jumping worms through use of a turf fertilizer that has vermicidal action, biochar and heat application, but results are anecdotal and will require formal research.

Emerald ash borer (EAB, *Agrilus planipennis*)

Areas of ash mortality and decline expanded to 4,636,857 acres (Figure 6) in 2017. In 2016, ash mortality on the western side of the state was limited to areas along the Mississippi River. However, in 2017, dead and declining ash trees were observed far inland from the river. The mortality surrounding the initial infestation in Newburg (Figure 7), in western Ozaukee County, expanded northward into forests with a high component of ash. The surrounding band of crown dieback also moved northward following forested land along the Lake Michigan shoreline and into the lowlands south of Lake Winnebago. In the southeastern counties, ash is more scattered in rural areas though abundant in communities. In the southeastern counties, ash is widespread in rural and urban forests. In these counties, the area where ash mortality predominated expanded as trees showing decline in 2016 succumbed.

Figure 6. Areas where ash mortality was predominant are indicated in red; areas where ash decline was predominant are indicated in yellow. The map for 2017 appears stippled as the areas of damage were overlaid on the distribution of ash.



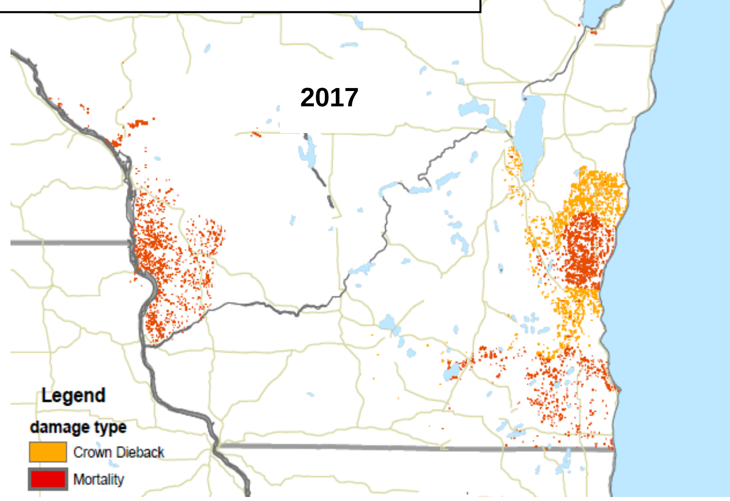


Figure 7. Forest of dead ash behind green hedgerow. Photo by Bill McNee

EAB continues to spread in Wisconsin. In 2017, the pest was found for the first time in an additional eight counties, which were subsequently quarantined: Chippewa, Eau Claire, Green Lake, Iowa, Marathon, Marinette, Waupaca and Waushara counties. This brings the total number of counties quarantined for EAB to 49 out of a total of 72 counties (Figure 8). For a historical review of the spread of EAB in Wisconsin since its initial identification in 2008, see the report on this species in the [Wisconsin DNR Forest Health 2016 Annual Report](#).

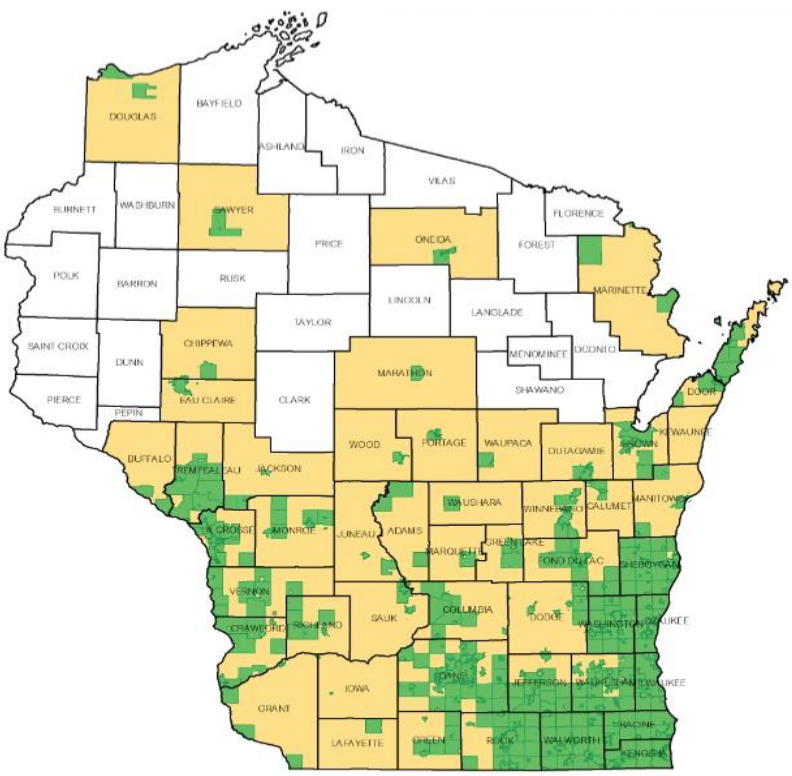
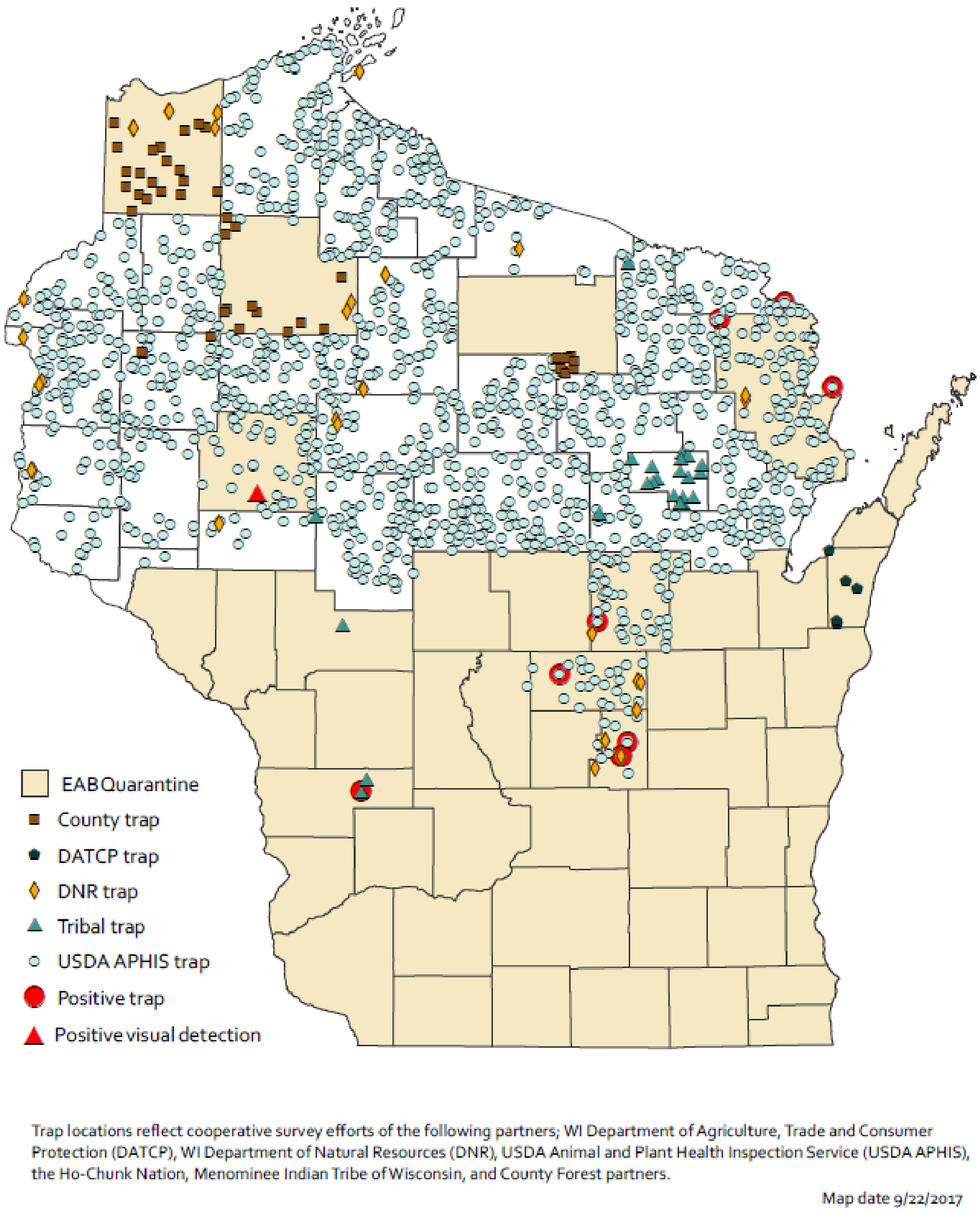


Figure 8. EAB distribution and quarantine as of December 2017. Counties in yellow are quarantined for EAB. Municipalities within the quarantined counties where EAB was detected are indicated in green.

Figure 9. 2017 EAB trap locations, results and agency responsible.



Several agencies, tribes and, for the first time, county forestry programs cooperated in monitoring for the presence of EAB (Figure 9). USDA APHIS continued detection trapping in counties un-quarantined at the start of 2017. Trap locations were selected using an algorithm to identify areas where EAB were likely to be introduced and then establish. DATCP set traps at high risk locations in Kewaunee County, which was quarantined but where EAB had not yet been confirmed. WI DNR placed traps at selected state properties and provided technical assistance to county forestry staff engaged in trapping county lands. Cooperating state agencies continued to take reports, make identifications and keep track of all municipalities where EAB was confirmed. A current list and map of all locations where EAB has been confirmed is available online at the Wisconsin emerald ash borer website.

Biological Control of EAB

2017 is the seventh consecutive year in which DNR staff and community cooperators released natural enemies of EAB in Wisconsin. Tiny parasitoid wasps - *Tetrastichus planipennisi, Spathius galinae* and *Oobius agrili* - were released at 17 sites in eastern Wisconsin between mid-June and early October (Figure 10). These parasitoids were introduced for the first time in the city of Green Bay in Brown County and in Sheboygan County, bringing to 15 the total number of counties where releases have been made in Wisconsin since 2011. Parasitoids are reared by the USDA APHIS Plant Protection and Quarantine EAB Parasitoid Rearing Facility in Brighton, Michigan. The wasps are supplied to states with established populations of EAB at no cost.

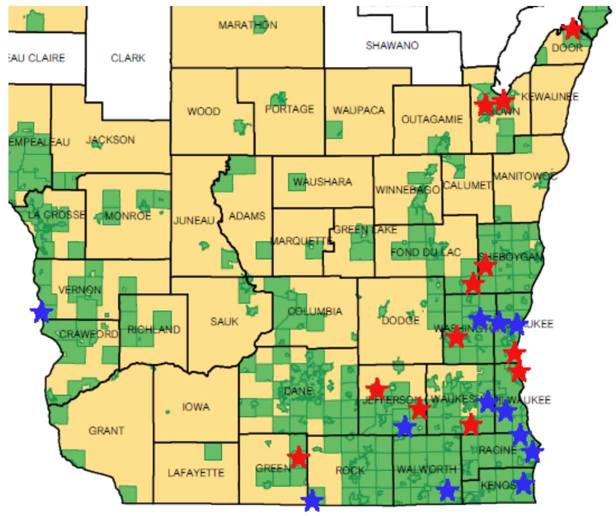


Figure 10. Release sites of natural enemies of EAB. 2017 sites are shown in red; wasps were also released at some of these sites in 2016. Releases accomplished in previous years (2011-16) are shown in blue. Communities where EAB was detected are shown in green.

Figure 11*. Spathius galinae* wasp actual body size is 1/3 in. long. Photo by Bill McNee

2017 was the second year *S. galinae* was released in Wisconsin (Figure 11); in 2016 it was introduced at sites in Brown County. This year, releases of *S. galinae* were made again in Brown County and in Door, Fond du Lac, Milwaukee, Ozaukee, Sheboygan, Washington and Waukesha counties. *Spathius galinae* is more cold-tolerant than the previously released *S. agrili*, which did not establish well in northern states. *Spathius* sp. have longer ovipositors than *T. planipennisi*, allowing them to attack EAB larvae beneath thicker bark and avoiding direct competition between parasitoid species that both attack the larval stage of EAB. *Oobius agrili* attacks EAB eggs on the bark surface. These specialist parasitoids were introduced with the expectation that they will provide downward pressure on EAB populations in the future, allowing the survival of ash trees with partial resistance to EAB. These tiny wasps do not sting or bite people and, because of their small size, the public is unlikely to ever notice them.

Tetrastichus planipennisi was successfully recovered by DNR staff at three sites in Milwaukee, Ozaukee and Washington counties, indicating that the wasps released in 2014 successfully established and have likely been attacking EAB larvae since. *Tetrastichus planipennisi* was previously recovered from release sites in Kenosha, Ozaukee, Racine and Walworth counties. Tree bark samples from the three 2017 sites were incubated to collect any *O. agrili* adults that emerged from parasitized EAB eggs, but no specimens were found. Recovery surveys will continue at introduction sites every two to three years after wasps are released. The delay will allow populations of the released parasitoids to increase to detectable levels.

Gypsy moth (*Lymantria dispar*)

In 2017, the DNR's gypsy moth suppression program aerially treated 247 acres at two sites in Devils Lake State Park (Sauk County) and 188 acres at three sites in Madison (Dane County). Foliage was successfully protected in all five treatment areas. Although the 435 acres treated in 2017 was Wisconsin's largest gypsy moth suppression program since 2011 (Figure 12), the total acreage was comparatively small compared to spray programs in other states where gypsy moth is established.

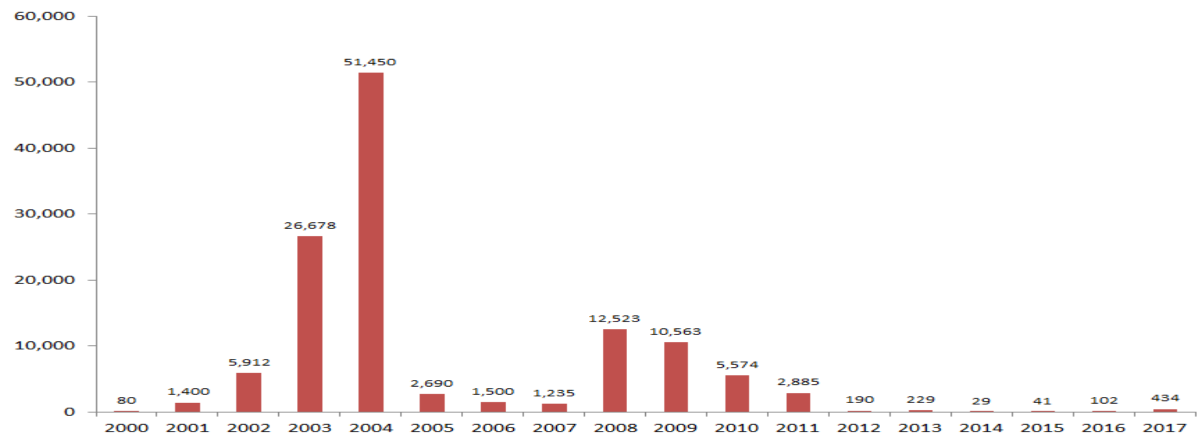


Figure 12. Acres treated in Wisconsin to suppress gypsy moth, 2000-2017.

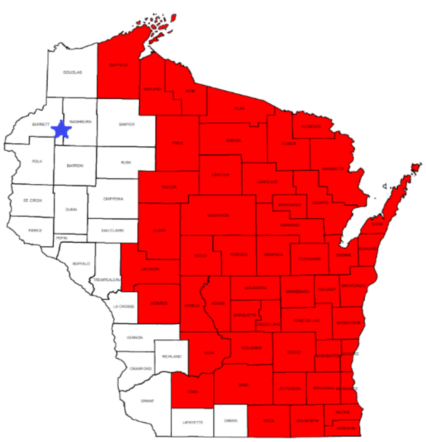


Figure 13. Location of an isolated gypsy moth outbreak in Burnett County is indicated by a blue star. Counties quarantined for gypsy moth are shown in red.

Statewide, the population of gypsy moth remained low. No damage was recorded with the unexpected exception of 60 acres in Burnett County, located about 35 miles outside of the gypsy moth quarantine area (Figures 13 and 14). Aspen, birch, white oak, red oak, red maple, red pine and white pine were defoliated across the property; severity of damage ranged from light to heavy. A seven-acre block of 15-year-old aspen trees suffered over 75% defoliation. Larval mortality from gypsy moth nucleopolyhedrosis virus and the bacterium *Entomophaga maimaiga* was present at low levels at the site. As is typical during defoliation events, larval maturation was accelerated and male moth flight occurred July 9, only four days after the first Wisconsin report of flying male moths

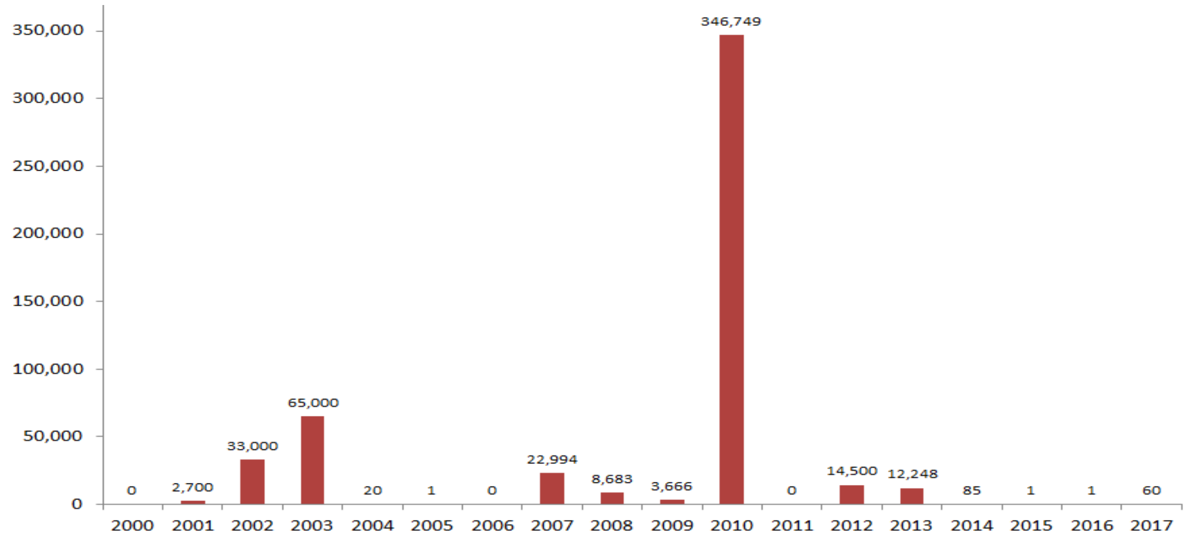


Figure 14. Acres defoliated in Wisconsin by gypsy moth 2000-2017

in Dane County, nearly 300 miles south. This outlying population is targeted for intensive treatment in 2018 by the national Slow the Spread program. For this reason, the county was not added to the quarantine in 2017.

Heterobasidion root disease (HRD, *Heterobasidion irregulare*)

Heterobasidion root disease (HRD) is one of the most destructive conifer diseases in the northern hemisphere. It is a concern in Wisconsin due to uncertainty about how long it will prevent the growth of pine trees once land is infested. HRD, caused by the fungus *Heterobasidion irregulare*, was first detected in Wisconsin in 1993 in Adams County. The disease has since been found in 27 counties (Figure 15). Although it was not observed in any new counties in 2017, HRD was identified at several novel sites within the previously confirmed counties of Portage, Sauk, and Waushara. Most HRD infections in Wisconsin were found in red and white pine plantations. Wisconsin requires use of specified precautions against HRD on state-owned lands located within 25 miles of a known HRD location. In 2017, a committee of stakeholders began a review of the current HRD prevention guidance. The review is expected to be completed in 2018.

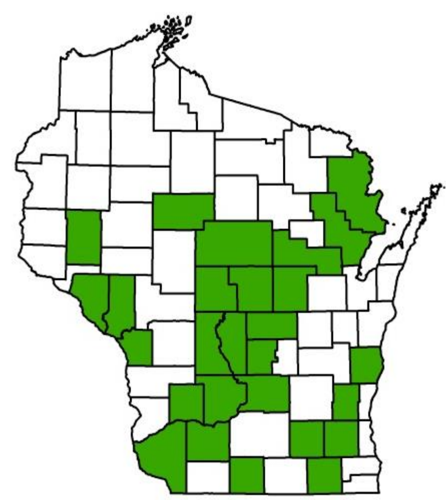


Figure 15. Wisconsin counties where HRD has been confirmed (Dec. 2017)

Invasive plant suppression program

The DNR's forest health team works to maintain and improve healthy forests by controlling invasive plants that hinder growth and regeneration (Table 1). This effort includes two grant programs. The **suppression grant program** targets emerging invasive plants that have not yet become widespread. It helps landowners become compliant with the state's invasive species law which forbids possession of prohibited plants. Second, the **weed management area-private forest grant program** supports the formation of weed management groups to control the spread of invasive plants regionally and locally; an example is the Lower Chippewa Invasives Partnership.

Table 1. High priority invasive plants controlled in 2017 by the invasive plant program

Common name	Scientific name	Classification*	Counties where control action was performed
Amur cork tree	*Phellondendron amurense*	Prohibited	Adams, Dunn
Giant hogweed	*Heracleum meanegazzianum*	Prohibited	Sheboygan
Japanese wisteria	*Wisteria floribunda*	Prohibited	Adams
Lesser celandine	*Ranunculus ficaria*	Prohibited	Dane, Kenosha, Milwaukee, Racine, Walworth
Policeman's helmet	*Impatiens glandulifera*	Prohibited	Dane, Shawano
Porcelain berry	*Ampeloposis brevipenduculata*	Prohibited	Dane
Princess tree	*Paulownia tomentosa*	Prohibited	Iowa, Sauk
Black swallow-wort	*Vincetoxicum nigrum*	Split-listed	Walworth, Waukesha
Japanese hedge parsley	*Torilis japonica*	Split-listed	Dane
Wild chervil	*Antrhiscus sylvestris*	Split-listed	Chippewa, Columbia, Dunn, Milwaukee
Tree-of-heaven	*Ailanthus altissima*	Restricted	Sauk

**Prohibited species* refers to species that are infrequent or absent in Wisconsin and may not be possessed by a landowner. *Restricted species* are more widespread and may be possessed. *Split-listed species* are prohibited in some counties and restricted in others.

Between July 1, 2016 and June 30, 2017, the forest health team's invasive plant program used $20,000 from its annual suppression grant funding as match to secure a grant from the U.S. Forest Service's cooperative lands program. The grant doubled the funding available to control emerging invasive plants which threaten Wisconsin's forests. These funds were used to control eleven species of high-priority invasive plants (Table 1). Funding was passed through to those local cooperators best-prepared to control the invasive plants in question, including private contractors, weed management groups, and private landowners. Control work was conducted on 57 properties (mostly private and municipal) in 14 counties and included tree felling, herbicide treatments and hand pulling, following landowner outreach and education to gain permission for control work.

Amur cork tree (*Phellodendron amurense*)

Figure 16. Fifty-year-old Amur cork tree cut and treated with herbicide to prevent growth of stump sprouts. Photo by Ken Roberts

Although the invasive Amur cork tree is aggressively moving into forests in other Midwestern states, it is currently found in just four Wisconsin counties. In 2017, control work began in two of these counties, along with preparations to start control in the remaining two counties. Property owners were encouraged to use the felled trees; a list of mills was provided for those interested in working with cork tree wood. Control work in Adams County was conducted on six private properties (Figure 16).

In Dunn County, control of Amur cork tree was accomplished on nine properties. Ninety trees were removed through efforts of the Lower Chippewa Invasives Partnership. Salvaged cork tree lumber was used for outdoor deck planks and wood working projects. Local media reported favorably on these efforts.

Lesser celandine (*Ranunculus ficaria*)

Control of lesser celandine is complex and difficult. What started with a small number of occurrences and some old records led to the discovery of an infestation of approximately 1,000 acres in Walworth County, involving as many as 200 landowners. Increased awareness of the plant from outreach efforts resulted in additional reports from Milwaukee and surrounding counties (Figure 17).

The life cycle of lesser celandine complicates control efforts. This ephemeral plant appears in April. It flowers, forms vegetative reproductive growths, and then dies back by early June. The plant is only visible for a short time, making it difficult to take new finds from discovery to treatment before the plant goes dormant underground, where it cannot be treated. Consequently, the forest health team staged its efforts by treating previously known populations for which they had pre-arranged landowner permissions. When new detections are made in early spring, DNR forest health staff contacts landowners and provides information on plant identification and control methods. Land owners are provided the same information when reports come in later in the year, but, in addition, those landowners are encouraged to plan control actions the following spring.

All known populations of lesser celandine occur in forested urban areas, including nature preserves. Control efforts not only protect urban forests but help reduce the risk that lesser celandine will be transported to the northern forests, where many people from southeastern Wisconsin have second homes. Control and outreach efforts are focused on informing people with lesser celandine not to transplant it to northern forests.

DNR forest health staff developed a network of local cooperators, including a weed management group, conservation groups, a garden club, and University of Wisconsin Extension personnel who continue outreach efforts. Additionally, a fact sheet for future mailings was produced with information on plant identification, herbicide treatments, and the permit requirements for their use in wet areas.

Tree-of-heaven (*Ailanthus altissima*)

Tree-of-heaven is relatively common in urban settings in southeastern Wisconsin. However, in 2017, a small population was found for the first time in rural Sauk County (Figure 18). This was of special concern due to the trees' location at the headwaters of the Wisconsin River State Riverway. The riverway is biologically important with extensive floodplain and upland forests throughout its nearly 50,000-acre area. It hosts 147 state species that are endangered, threatened, or of special concern.

Department staff contacted public and private landowners for permission to remove the trees on each property in the fall of 2017. Additionally, two local governments volunteered to control tree-of-heaven on their properties, at no cost to DNR. Sauk County highway department removed tree-of-heaven while constructing the Great Sauk State Trail, a rails-to-trails project, while the village of Prairie du Sac removed it from a park through which the trail project passes.

Figure 18. This seed-producing tree-of-heaven in Sauk County was destroyed in 2017. Photo by Mike Putnam

Oak wilt disease (caused by *Ceratocystis fagacearum*)

Oak wilt disease is caused by the pathogenic fungus *Ceratocystis facecare*. Lethal to northern pin, northern red and black oaks, the disease is widespread in the southern two-thirds of the state, although it is still uncommon in northern Wisconsin (Figure 19). However, DNR forest health staff continue to find isolated disease centers in northern Wisconsin each year.

In 2017, oak wilt disease was detected in Sheboygan County for the first time. Wood samples from a suspect red oak in the Kettle Moraine State Forest tested positive for the fungal pathogen. Identification of the fungus was done through DNA testing at the DNR Forest Health Lab and DNA sequencing at the University of Wisconsin–Madison's Biotechnology Center. As of December 2017, oak wilt has been detected in 62 of Wisconsin's 72 counties.

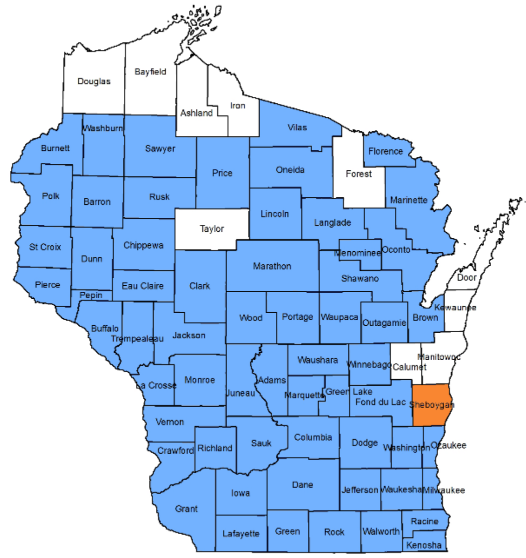


Fig 19. Sheboygan County, where oak wilt was found for the first time in 2017, is shown in orange. Counties where oak wilt has been detected previously are shown in blue.

Hardwood issues

Bur oak blight (BOB, *Tubakia iowensis*)

Bur oak blight was initially found in Wisconsin in 2010. In 2017, BOB was confirmed for the first time in Brown, Ozaukee, and Racine counties in samples sent to the University of Wisconsin, Plant Disease Diagnostics Clinic. BOB continued to be recorded in urban and forested areas in counties where the disease was previously found. Currently, the disease has been confirmed in 27 counties (Figure 20).

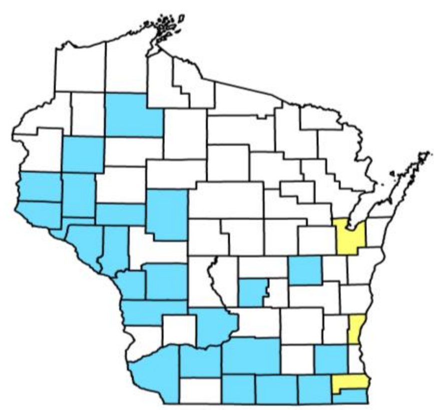


Figure 20. Counties in Wisconsin where bur oak blight was found in 2017 are yellow, previously confirmed counties are blue.

Phytoplasma (*Candidatus Phytoplasma fraxini*)

Phytoplasmas are small bacteria that lack cell walls and live as obligate parasites and pathogens of plants. In trees, they cause small and yellowed foliage, slow growth, thin crowns, branch dieback and vertical bark cracks. Due to characteristic foliage chlorosis, the disease is called "yellows disease". Infected trees and stumps may produce clusters of spindly shoots called 'witches broom'. Broom formation is highly variable and often absent in infected trees depending on the host species. Once an infected tree is cut, however, brooms are often produced prolifically (Figure 21).

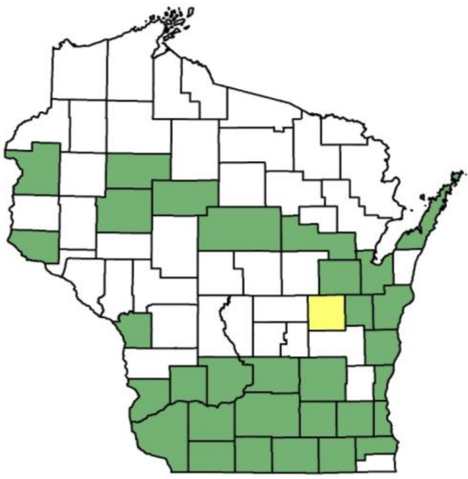


Figure 22. Counties in Wisconsin where phytoplasma has been confirmed: Winnebago Co., added in 2017, is yellow, previously confirmed counties are green.

Figure 21. Witches broom stump sprouting with yellowed foliage typical of phytoplasma infection. Photo by Kyoko Scanlon

Phytoplasma (*Ca.* P. fraxini) was first confirmed in Wisconsin in white ash in 1987. Since then, the resulting disease has been found in 32 counties, with Winnebago County joining the list in 2017 (Figure 22). In Wisconsin, phytoplasma has been confirmed in 15 tree species using the genetic test, polymerase chain reaction (PCR). It is uncertain if the phytoplasma found in different hosts is the same species, as the PCR test performed does not identify phytoplasma to specific group/subgroup.

Japanese beetle (*Popillia japonica*)

Japanese beetles started to emerge in southern Wisconsin in early July (Figure 23). Some areas of the state have building populations while others, like the Madison area, have populations that exploded in the past and are more stable now. A very wet spring and early summer is likely to have favored survival and population growth of this invasive pest. Japanese beetle adults feed on

Figure 23. Japanese beetle adult defoliating basswood. Photo by Linda

flowers and leaves of over 300 plant species, including trees, shrubs, and herbaceous plants. They can cause significant defoliation. The larval stage of Japanese beetle is a white grub that lives in the soil and feeds on plant roots.

The Minocqua/Woodruff area had a newly building population of Japanese beetles in 2017 in which defoliation was significant throughout the city, particularly on birch. Defoliation was most predominant in the lower canopy, but some trees were heavily defoliated top to bottom. Japanese beetle populations are also building up for the first time in many communities throughout central Wisconsin, generating calls for identification and control recommendations.

Conifer Issues

Eastern larch beetle (*Dendroctonus simplex*)

Eastern larch beetle, a native insect, attacks tamarack by tunneling under the bark, girdling and eventually killing the tree (Figure 24). Scattered damage and mortality from eastern larch beetle was first noticed in the state in 1999; these incidents have been mapped each year since 2012. In 2017, scattered tamarack were killed over 2,350 acres in Forest, Oconto, Oneida, and Vilas counties. Like other bark beetles, eastern larch beetle first attacks stressed trees, but once the beetle begins to kill trees in a stand, it usually continues to move through the stand, even if there are no further obvious stress events. Inciting stressors may have included drought in 2012-2013; larch casebearer defoliation in 2014; and record rainfall throughout the growing season flooding stands for extended periods in 2017.

Figure 24. Woodpeckers strip bark off tamarack infested by eastern larch beetle, giving the trees a reddish appearance. Photo by Linda Williams

State nursery disease studies

Asymptomatic infection by *Diplodia sapinea* in state nursery stock

Asymptomatic infection by *Diplodia sapinea* in red pine seedlings can result in failure of the plantation when the disease becomes symptomatic after planting. In Wisconsin state nurseries, healthy-looking red pine seedlings have been tested annually to assess for asymptomatic infection prior to sale. The asymptomatic infection rate must be 10% or less or the stock will not be sold. In 2017, the forest health lab tested seedlings from the Wilson Nursery. The infection rate for 2-year old seedlings (256 seedlings tested) was 0.4% and 3-year old seedlings (240 seedlings tested) was 2.9%.

Survey of galling in jack pine seedlings at the Wilson Nursery

Historically, gall incidence on jack pine seedlings is very low in the state-owned Wilson Nursery. Surveys conducted in 2009-2012 showed 0% to 0.5% gall incidence rate on one-year old jack pine seedlings. However, an increased number of galled seedlings were detected and discarded at the time of lifting in spring 2016. In response, the nursery and forest health staff surveyed jack pine seedlings for galls at the time of lifting in the spring of 2017. One thousand one-year-old jack pine seedlings were randomly selected and thoroughly examined in the lab for the presence of galls. Based on the visual inspection, the rate of gall incidence on one-year old jack pines was 2.9% in 2017, an increase from historical levels. This increase in the level of galling is concerning; treatment to prevent jack pine gall rust was started this year, and monitoring for disease-lifted seedlings will continue in spring 2018.

Jack pine budworm (*Choristoneura pinus*)

DNR forest health and reforestation program staff worked together to protect jack and red pine from further defoliation by jack pine budworm at the state-owned Ten Mile Seed Orchard. In 2016, jack pine budworm defoliated jack and red pine in the seed orchard, leaving trees stressed and vulnerable to mortality if the damage from this pest reoccurred. In response, DNR staff contracted to have 22 acres sprayed aerially with Foray, a bacterial insecticide with an active ingredient of *Bacillus thuringiensis kurstaki*). Treatment was successful in preventing defoliation of the seed trees. Other than at the seed orchard, the population of jack pine budworm was low across the state in 2017.

Spruce budworm (*Choristoneura fumiferana*)

Defoliation of spruce and balsam fir due to spruce budworm (Figure 25) in 2017 was less than that observed in 2016. Although most defoliation occurred in northern counties, some localized areas of significant defoliation were noted in Shawano and Oconto Counties.

Due to multiple storms with heavy rains and strong winds in the spring of 2017, most of the clipped needles and webbing which usually make defoliation more noticeable were washed off the trees, so reports of defoliation were low. Additionally, the large amount of rainfall throughout the year in 2017 allowed for ample new growth on spruce and balsam, so, although defoliation was present, it was less evident. Trees in areas of Bayfield, Florence, Iron, Marinette, and Vilas counties had patchy light or moderate defoliation, with localized areas of continuing severe defoliation. The spruce budworm population crashed at a site in Portage County, although dieback and mortality increased significantly.

Figure 25. Spruce budworm caterpillar photo by Mike Hillstrom

Regional budworm outbreaks occur every 30-50 years and can last 10-15 years. Wisconsin's last outbreak ran from 1970 to 1980. Mature balsam fir and spruce are the primary targets, although younger balsam or spruce can be defoliated as well. Repeated defoliation can cause top-kill and eventually whole tree mortality.

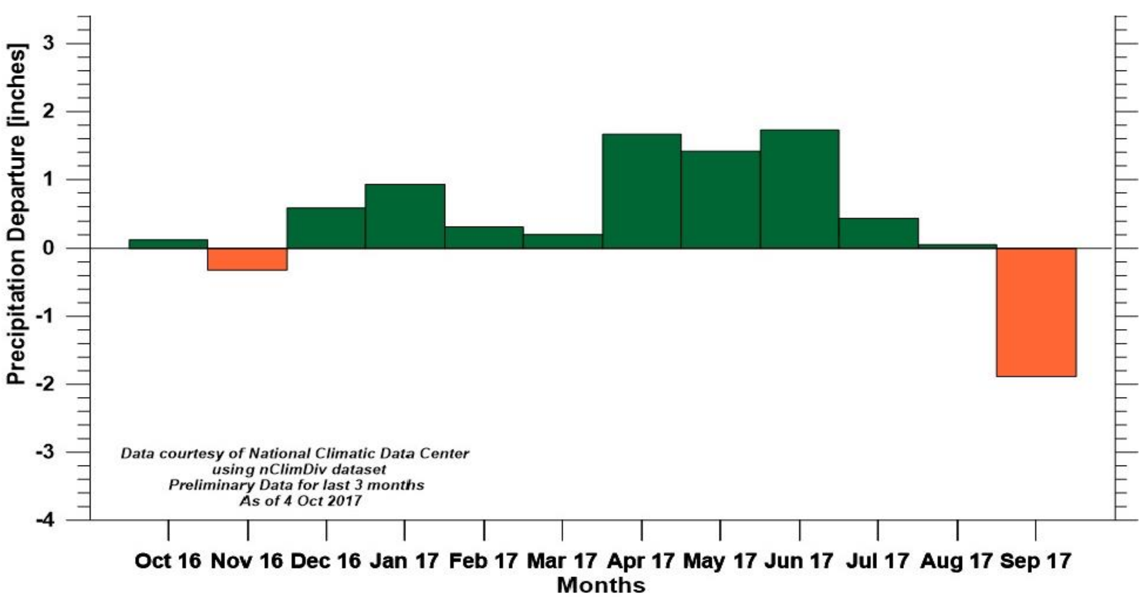
Abiotic Issues

Temperatures were above average early in 2017 and fluctuated around average during spring and summer. Frost damage was more localized in 2017 than during the past few springs, but did severely impact oaks and to a lesser degree ash in areas of northeastern Wisconsin. Forest health staff also received several calls about frost damaged aspen, cottonwood and willow in sporadic locations around Wisconsin.

Precipitation was well above average until a dry period in late summer occurred (Table 2). In fact, January through July 2017 was the wettest period Wisconsin has experienced in the 123 years data has been collected. The average rainfall across the state was 25.25 inches, which is 7.14 inches above average according to the National Weather Service.

Flood and other storm damage occurred in forests and urban trees in many areas of Wisconsin. Forest health specialists suspect storm damage from May to July led to a number of new oak wilt infestations in impacted areas. The wet weather also led to abundant leaf and needle diseases such as anthracnose. Plentiful precipitation similarly played a role in insect populations. Japanese beetle larvae thrive with consistent soil moisture; the consistent rain in recent years has resulted in large populations of this pest in Wisconsin in 2017. In contrast, the wet, humid spring led to another year of high mortality rates for gypsy moth caterpillars from disease.

Table 2 Wisconsin statewide monthly precipitation departures from 1981-2010 normals. Oct 2016-Sept 2017, WI State Climatology Office



Severe storms in 2017 caused significant damage from tornadoes, wind throw, flooding, and hail across the state:

- In April, a strong line of storms moved through Wisconsin that produced hail, straight-line winds and a tornado in northern Wisconsin.
- In May, a major storm system swept through northern Wisconsin. An EF3 tornado, which was later documented to have the longest path on record in the state (70 miles long and up to 2 miles wide), caused severe damage to more than 10,000 forested acres in northwest Wisconsin. Later, this storm system spawned an EF-0 tornado and straight-line winds that damaged county and state forests farther east.
- In mid-June, several days of storms produced numerous tornadoes, straight-line winds, hail and flash flooding across Wisconsin.
- In July, hail damage occurred in several western Wisconsin counties.
- Localized flood damage to forests occurred in many areas of Wisconsin in May, June and July 2017. Some damage occurred rapidly from flash flooding while other damage appeared later from water pooling in lowland areas longer than normal and the continued rise in river and lake levels over the past few years.

Figure 26. Blowdown on the Oneida County forest in May 2017. Photo by Ricky Keller

Acknowledgements

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