

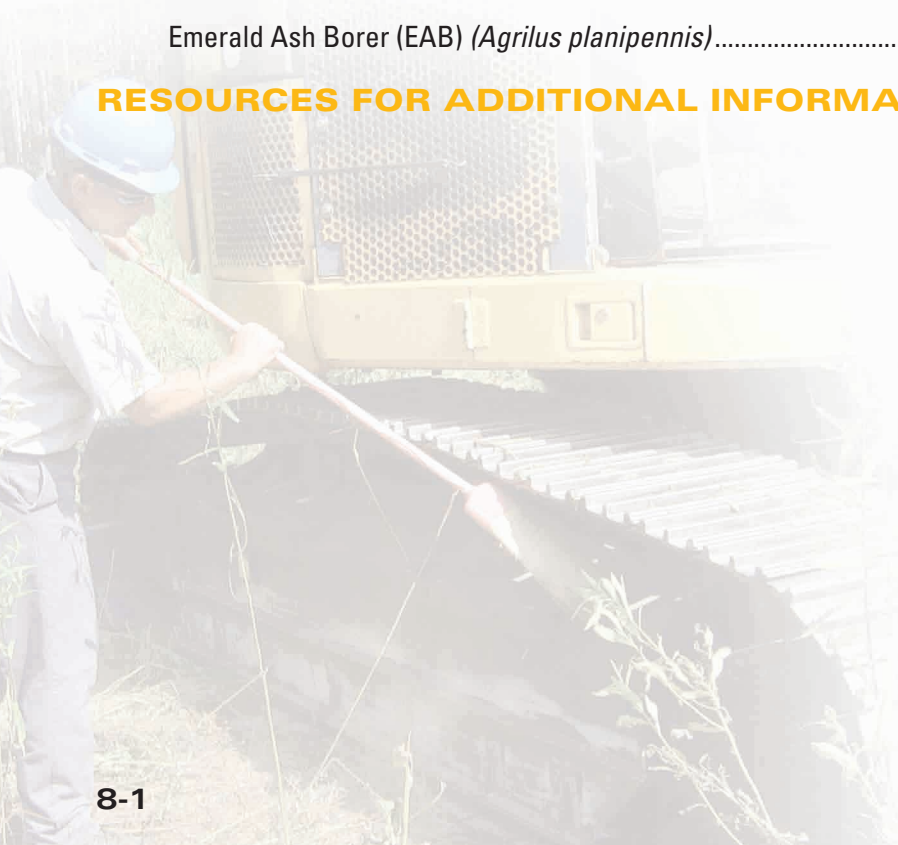


CHAPTER 8

Threats to Forest Health

CHAPTER 8 THREATS TO FOREST HEALTH

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WHAT ARE THREATS TO FOREST HEALTH?

There are many factors that can affect the health of a forest. Some are abiotic, such as damage from wind, drought, hail, or fire. Others are biological, such as insects, disease-causing organisms, and worms and plants which compete with desirable forest species. This chapter only addresses biological threats to forest health and productivity.

Wisconsin forests have a long co-evolutionary history with native insects and diseases, but these natives can still be very damaging. Forest tent caterpillar and spruce budworm are two native pests that periodically increase to very high populations and cause heavy defoliation

and mortality of their hosts. However, outbreaks are naturally limited by natural enemies of the pests and/or the overinflated pest population changing the conditions that favored the development of the outbreak. For example, a jack pine budworm outbreak leads to defoliation and death of mature jack pines that supported initial growth of the pest population; as the budworm population faces starvation, it becomes vulnerable to attack by disease and parasitoids. Starting in the early twentieth century and increasingly in recent years, nonnative pests and diseases have presented a greater threat to Wisconsin forests. For this reason the focus of this chapter will be on invasive species.

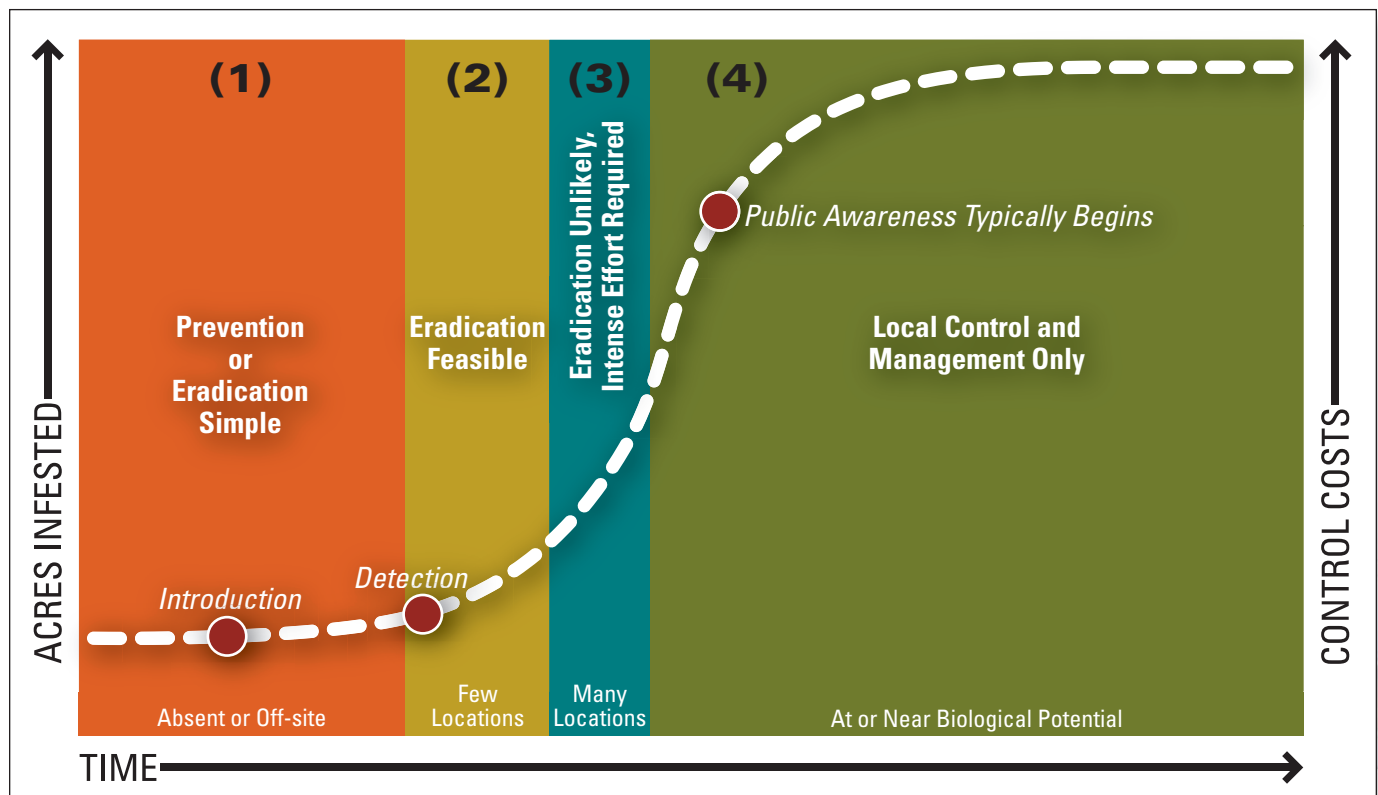


Figure 8-1: Invasive Plant Increase Over Time and Control Potential. The process of invasion is characterized in four phases. The first phase (1) is the introduction phase where prevention or eradication is possible. Typically an introduced species must survive at low population densities before it becomes invasive in a new location; some species are present for many years before they exhibit damaging potential. The second phase (2) has a few populations and eradication is still feasible, though increasingly difficult. If an invasive species is detected early, when it is only found in low numbers in a few locations, it may be possible to eradicate it. The third phase (3) is characterized by many more populations and eradication is unlikely, though it may be possible to slow the spread of the species from the area of infestation. The fourth phase (4) begins when the population is at or near its biological potential and local control and management of damage inflicted by the species is the only option.

(Figure Credit: The Nature Conservancy, John Randall)

WHAT ARE INVASIVE SPECIES?

For the purposes of this guide, any plants, insects, worms, and disease-causing organisms are considered invasive if they are not native to an area and cause harm to ecosystems, the economy or human health.

Most species that have been accidentally or deliberately introduced and established cause no harm or may even be considered beneficial (e.g., daffodils, honeybees). Only a small proportion of these nonnatives have gone on to cause damage and be classified and/or regulated as invasive species (e.g., garlic mustard, emerald ash borer). Even among these invasive species, a few may have useful characteristics that are valued by some people (e.g., reed canary grass).

A notable difference between native and invasive pests and diseases is that invasive species are often harder to control. One reason control of invasives presents a challenge is these species generally possess the advantage of having arrived in an area absent of natural enemies and competitors that keep them largely in check in their native range. In addition,

native host species that did not evolve alongside the invasive species are unlikely to have evolved effective defenses against them, allowing the invasive to attack relatively unopposed.

The number of introductions of foreign species has been increasing dramatically since the early 1900s and remains on the rise. This increasing trend of introductions parallels the increasing volume of global trade. The increasing speed with which cargo moves from continent to continent and around the country favors survival of plants and insects that hitchhike in cargo. In the past, cargo containers were opened at the first point of entry, which somewhat limited the spread of nonnative species, but in the present day, cargo containers are quickly transported to their final destination before unpacking, effectively transporting nonnative species to a wide range of new destinations every year. The introduction of invasives is only expected to increase over the coming years, therefore, invasives pose both a present and future threat to forest health in Wisconsin.



Figure 8-2: Japanese barberry for sale at a nursery.



Figure 8-3: Japanese barberry invading a woodland.

INVASIVE SPECIES ARE A THREAT TO FORESTS



Figure 8-4: Notice abundant sugar maple seedlings in the stand without worms, compared to the absence of tree seedlings where worms are present.

Invasive insects and diseases have had a significant, negative impact on several commercially important tree species, causing widespread mortality in some and a reduction of growth in others. Invasive plants and worms can have a more forest-wide effect, preventing successful regeneration of tree species and eliminating most native species of the herbaceous layer.

- **Emerald ash borer (EAB)** attacks and kills all North American species of ash it has encountered. There appear to be individuals with some resistance but it is rare. This pest has the potential to cause the commercial extinction and possibly the actual extinction of ash species on this continent. Commercial extinction is the reduction of a species to such low numbers that, although it is still present, harvesting it is no longer profitable.
- **Chestnut blight (*Cryphonectria parasitica*)** killed all American chestnut back to their rootstocks within 40 years, resulting in the economic extinction of this valuable and formally abundant species. The species survives as sprouts on dwindling rootstocks and in isolated groves far from the native range.
- **Gypsy moth** preferentially feeds on oaks, causing repeated defoliation during the development and peak of outbreaks which weakens and contributes to mortality of even dominant trees.
- **Beech bark disease complex** (of an invasive scale and either a native or an invasive *Nectria* fungus) rapidly kills American beech. Between one and five percent of the beech population is resistant to the scale disease, and holds the hope of recovering this species. However, the genetic bottleneck it will go through is expected to reduce genetic diversity and may leave the species vulnerable to other pests and diseases.
- **Dutch elm disease** has removed American elm as a canopy dominant species in lowland forests, although the species persists as a short-lived tree along forest edges.
- **Invasive plants** directly impact forest health and species composition by reducing tree regeneration, growth and longevity. Common buckthorn (*Rhamnus cathartica*) and nonnative earthworms alter forest soil structure and chemistry impacting tree regeneration and growth (Bohlen et al. 2004, Heneghan et al. 2004, 2006).
- **Invasive worms** devour the layer of leaf mold many northern forest trees and herbs require for seedling survival. Worms also compact the soil and homogenize the layers to the detriment of adult trees.

INVASIVE SPECIES AND FOREST MANAGEMENT

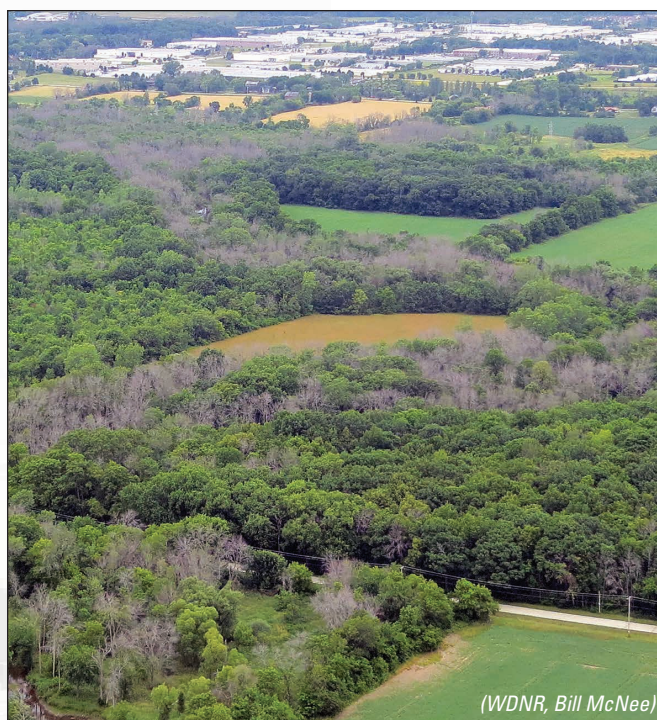


(J. Cardina)

Figure 8-5: The garlic mustard that dominates the understory in this stand will greatly impact forest stewardship.

As invasive species spread to new areas, forest management or stewardship plans may need to be adjusted to minimize or account for the impact invasives may have on achieving the goals of the plan. Talk with your forester about invasive species that could impact the plan for your forest, and learn how to identify and manage species spreading into or increasing in abundance in your area. Stay alert for their presence and impact on your property, and if necessary, work with your forester to adjust the management plan to maintain a productive and sustainable forest. For example:

- Where established, emerald ash borer (EAB) is killing all ash trees. Managers of properties where the loss of ash would impact their forest stewardship goals should work with their forester to minimize financial losses from EAB, and to regenerate a diverse forest in the wake of the killing front from this pest.
- Increased competition from invasive shrubs including buckthorns and honeysuckles has made regeneration of desirable forest trees impossible if the invasive plants are not controlled following thinnings or harvests. Treatments to reduce invasive plants may need to be added to stewardship plans where these plants are abundant.



(WDNR, Bill McNeel)

Figure 8-6: Extensive ash mortality caused by EAB in southeast Wisconsin.

Forest management activities can create site conditions suitable for many opportunistic invasive species. These conditions can occur through site disturbance that exposes soil and creates a seedbed for invasive plants, or by releasing invasive plant seeds that are already present. Forest management activities may also increase the likelihood of invasive **propagules** being accidentally introduced to a site. However, some simple precautions can largely reduce the risk of inadvertently introducing or encouraging invasive plants, worms, diseases and pests. When planning control of one invasive species, keep in mind that others may also need to be managed at the same time for successful maintenance of the forest.



Figure 8-7: Common buckthorn was removed from this stand to promote regeneration. The ensuing disturbance allowed garlic mustard to take hold and flourish.

PROPAGULE

Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.



Figure 8-8: The brushing activity has created a favorable bed for invasive plants to grow. It is important to understand the species that were removed as well as those that are nearby, in order to achieve regeneration of desirable species.

ELEMENTS OF INVASIVE SPECIES MANAGEMENT

Invasive species management includes several elements: prevention, early detection and rapid response, control, monitoring, and restoration. Depending on the invasive species you are managing and the situation on your property, your management plan will emphasize action in one or more of these elements.

- Prevention.** If a property is free of a potentially damaging invasive species, it makes sense to take precautions not to introduce them. Invasive Species Best Management Practices (IS-BMPs) are voluntary precautions that will reduce the risk of introducing many invasive plants, worms, pests and diseases. IS-BMPs have been developed for forestry activities, as well as for recreational users, transportation and utility corridor maintenance, and urban forestry. The IS-BMPs can be found at: www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/overview.
- Early Detection and Rapid Response.** If an invasive species is detected when its population is still low and isolated, it will be easier to eradicate or contain it. Detection depends on landowners or managers being aware of invasive species that pose a significant threat to achieving the goals for the property and where they are most likely to show up first. Timely response is easier if planned ahead of arrival of a damaging invasive.
- Control.** Where an invasive species is well established, management should focus on ensuring it doesn't prevent achievement of the goals for the property. The impact of some invasive species may be so severe that property goals may need to be modified. For most invasive species, however, management will be limited to specific areas of the property or when the population threatens to exceed a threshold for damage. Control programs can include manual, mechanical, chemical, biological, and/or cultural components.
- Monitoring.** Most landowners and land managers will not need complex monitoring programs. Instead, periodic inspections to detect new invasions and to evaluate the success of control measures can be performed. Monitoring can be integrated with other forest activities such as reforestation surveys.

- Restoration.** The process of restoration involves assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. For most properties, restoration will only be needed in extreme cases where a dominant native species has been eliminated by an invasive pest or disease or where the impact of invasive plants has been heavy and prolonged.



(Elizabeth Czarapata)

Figure 8-9: Black swallow-wort is a fast-growing vine that will climb trees and shrubs, ultimately engulfing the canopy and shading out its host. Populations are limited to areas in southern Wisconsin, so early detection of the plant is critical. Once identified, it should be controlled quickly to prevent its rapid spread.




(WDNR, Mike Hillstrom)

Figure 8-10: Traps are used to detect the presence of emerald ash borer.

FORESTRY BMPs FOR INVASIVE SPECIES






Invasive Species Best Management Practices (IS-BMPs) for forestry were developed by the Wisconsin Council on Forestry in 2009 and are intended to aid in the management and control of invasive plants, insects, and diseases in Wisconsin forests. They describe voluntary practices that may reduce the impact of invasive species during forest management activities. Applicable IS-BMPs have been included within several chapters to assist foresters, landowners and loggers in

incorporating invasive species issues in their forest management activities. IS-BMPs are identified by “” to help separate them from other recommendations in this guide. The numbers associated with the IS-BMPs refer to the actual BMPs within the forestry field manual *Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners, and Loggers* that can be found at: www.wisconsinforestry.org.







BMPs: General

The following are IS-BMPs that generally apply to all activities that take place during forest management. Consult *Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners and Loggers* in order to fully understand the intent and meaning of any given IS-BMP. Chapters refer to the specific chapters in the forestry field manual.

CHAPTER 3: MANAGEMENT PLANNING

-  3.1 Include a strategy for managing invasive species.
-  3.2 Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.
-  3.3 Consider the need for action based on: 1) the degree of invasiveness; 2) severity of the current infestation; 3) amount of additional habitat or hosts at risk for invasion; 4) potential impacts; and 5) feasibility of control with available methods and resources.
-  3.4 Plan management activities to limit the potential for the introduction and spread of invasive species.
-  3.5 Plan for post-activity management of highly damaging invasive species.

CHAPTER 4: FOREST STEWARDSHIP

-  4.1 Provide training in identification of locally known invasive plants and pests to forest workers.
-  4.2 If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.
-  4.3 Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.
-  4.4 Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.
-  4.5 Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.
-  4.6 Take reasonable steps to avoid traveling through or working in small, isolated, populations of invasives during forest stewardship activities.

MANAGEMENT OF SELECT FOREST PESTS AND DISEASES

Overall forest health can be encouraged by forestry practices that maintain vigorous growth of better quality trees. By maintaining a diversity of species in a forest, forest managers contribute to the resistance of the entire system to the spread of pests and diseases, and promote the recovery of forest function in the event a component tree species is reduced or eliminated. Occasionally,

however, it will be necessary to address individual pests or diseases that threaten the goals for a property. The following tables (Tables 8-1A through 8-1H) list some of the most common and damaging insects and diseases affecting Wisconsin's forests and key management considerations. You can visit the resources at the end of this chapter for more information.

WHITE PINE BLISTER RUST (*Cronartium ribicola*) TREE SPECIES AFFECTED: WHITE PINE



Figure 8-11: A bleeding canker caused by the fungus white pine blister rust (*Cronartium ribicola*).

- **Prevention** (if conditions are favorable for blister rust)

- Manage young white pine under an existing overstory.
- Plant two rows of a non-susceptible coniferous species, such as spruce, around a white pine planting. The spruce will help to disrupt the movement of infectious spores from gooseberry (*Ribes*) to white pine.
- Since lower branches are most likely to become infected, begin pruning lower branches of white pine when they are five to seven years old. Attempt to maintain 2/3 of the tree height in live branches. At no time should branches be pruned from more than 1/2 the height of the tree. Prune over time until bottom 9' (minimum) to 17' are free from branches.
- It is not necessary to prune every tree. Prune only trees on the outside rows bordering areas where there are *Ribes* plants, and the most desirable individuals in the interior of the stand. Aim to prune 100 to 200 trees per acre in

natural stands, and 350 per acre in pure white pine plantations.

- Avoid planting white pine adjacent to woodlots that contain *Ribes* plants, and exhibit conditions that enhance lasting dew formation such as frost pockets, small openings and north aspects.

- **Early Detection**

- Check trees for flagging branches (dying branches with brown foliage), particularly in lower 9' of stem.
- Look for areas of rough, dark bark where stem may be constricted and oozing pitch.
- In spring, check for yellow to orange blisters on branches or the trunk.

- **Control and Management**

- Trees with blister rust cankers on the main stem or within 4" of the main stem cannot be saved; therefore, pruning will not help.
- Branches with cankers located 4" or more from the main stem should be removed, no matter where they occur in the crown of the tree.
- Remove trees with cankers on the main stem during timber harvest or as soon as possible, as spores from active cankers will re-infect *Ribes* and increase the amount of disease in the area.

- **Monitoring**

- Look for new flagging branches each year and remove them.

- **Restoration**

- Needs and options will be site specific.

Table 8-1A: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for White Pine Blister Rust (*Cronartium ribicola*)

OAK WILT (*Ceratocystis fagacearum*)

TREE SPECIES AFFECTED: OAK

• Prevention

- **Urban/Residential Setting:** Oak trees are most susceptible to overland spread in spring and early summer. The Wisconsin DNR advises to avoid pruning, cutting or wounding oaks from April through July 15. If daytime temperatures reach 60°F for seven consecutive days prior to April, stop pruning as transmission of oak wilt is possible. Do not resume pruning until after July 15.
- **Forested Setting:** For information, refer to *Oak Wilt: Harvest Guidelines for Reducing the Risk of Introduction and Spread in a Forest Setting* at: dnr.wi.gov – keywords “oak wilt.”



Figure 8-12: Discolored red oak leaves infected with *Ceratocystis fagacearum*.

• Early Detection

- **Red Oak Group:** Look for leaves turning a bronze or water-soaked color and rapidly falling from the tree any time from late June to August, or trees losing a portion of leaves in September, and then rapidly losing all leaves just after leaf-out the following spring.
- **White Oak Group:** Trees drop leaves on one or more branches several years in a row.

• Control and Management

- **Underground Spread:** Disrupting root grafts can stop the underground spread of the fungus. Options include physically severing roots with a vibratory plow, cable plow or trencher. Not all sites are suitable for this option. Steep slopes prohibit the use of root barrier equipment and sites with large rocks inhibit barrier placement. Locating barriers correctly is crucial to success. Guidance on barrier placement is available in *Oak Wilt Management: What are the Options* (University of Wisconsin-Extension Bulletin G3590) or consult a forest health specialist. Other management methods to limit movement of the pathogen in roots chemically or physically have been implemented in the field with some success. Consult a forest health specialist for more information.
- **Overland Spread:** If healthy trees are wounded during the high risk period of April through July 15 in urban areas, the wounds should be treated with a tree-wound paint to prevent contact with sap-feeding beetles that transmit the fungal spores.

(Continued on page 8-11)

Table 8-1B: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Oak Wilt (*Ceratocystis fagacearum*)

OAK WILT (*Ceratocystis fagacearum*) (continued)

TREE SPECIES AFFECTED: OAK

Trees that die from oak wilt produce fungal fruiting mats typically the following spring. If this wood is moved, oak wilt spores will be released at the new location and the disease may spread into unaffected areas. **Wood from trees that have died from oak wilt and have bark that is still tightly attached could harbor fungal fruiting mats.** This wood must receive special treatment (see “Firewood” and “Other Wood Products”) before being moved. Once the bark has become loose and falls off the wood, the mats are no longer infectious. In that case, no special treatment is necessary and movement of the wood is no longer a concern.

- **Firewood:** Two methods of wood treatment are effective in preventing overland spread via firewood:
 - **Debarking** (removing the bark from the wood) will prevent the fungal mats from forming. Debarking must be conducted before fungal mats form, and should occur in the late summer, fall or winter following tree death.
 - **Cutting, splitting, stacking and covering the wood with 4 mil. or thicker plastic** will prevent overland spread. All sharp edges or stubs should be cut to eliminate the possibility of puncturing the plastic. The entire pile must be sealed all around. Seal the bottom by covering it with dirt. If the wood is not burned over the winter following tree death, leave the tarp on through the next growing season (until October 1) or until the bark is loose. Once the bark is loose, the wood is no longer infectious.

- **Other Wood Products:** Wood from infected trees may be utilized. Logs with tightly attached bark must be utilized before April 1. Wood chips from infected trees are **unlikely** to serve as a source of spores as chips dry out quickly, and the oak wilt fungus is not a good competitor with other wood decay fungi.
- **Monitoring**
 - Look for wilting foliage on oak trees late June to August.
- **Restoration**
 - Needs and options will be site specific.



Figure 8-13: Red oak rapidly losing its leaves in July; this tree is infected with *Ceratocystis fagacearum*, the cause of oak wilt.

Table 8-1B: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Oak Wilt (*Ceratocystis fagacearum*) (continued from page 8-10)

HETEROBASIDIUM ROOT DISEASE (*Heterobasidion irregulare*)

TREE SPECIES AFFECTED: RED OR WHITE PINE, SPRUCE AND OTHER CONIFERS

• Prevention

- Prevention of Heterobasidion root disease (formerly known as Annosum root rot) is the most important approach to management as there are no treatments for this disease once infection has occurred. A practical guide is available to help landowners/property managers determine whether a fungicide treatment should be considered to reduce the risk of introduction of Heterobasidion root disease to their pine stand at: dnr.wi.gov – search “root disease.” Information on fungicides registered for this purpose and application options are also available at that website.

• Early Detection

- Look for conifers with thinning crowns, reduced growth in height, diameter and shoots. Also be aware of individuals or pockets of dead and dying pine or spruce in the overstory and understory. Crown symptoms typically appear three to eight years after a thinning or partial harvest where stumps are left among living trees.
- Additionally, look for individuals or pockets of dead trees with fruit bodies at the root collar of dying or dead trees or stumps (to see this, you may have to pull the duff layer back).

• Control and Management

- Options for management are dependent on several factors. Details on options can be found at: dnr.wi.gov – search “root disease.”

• Monitoring

- See “Early Detection.”

• Restoration

- This fungus can survive for decades in wood. Expect some further mortality to occur to susceptible species when attempting regeneration. Deciduous trees are resistant to the disease; conversion to hardwoods should be considered, if it is appropriate for the site.
- After harvest, infected sites may be replanted or naturally regenerated to conifers. In the southeastern United States, regeneration losses have been documented to be a total of about five percent with additional disease development following thinnings. This data is currently not available for Wisconsin.



Figure 8-14: A pine stump with *Heterobasidion irregulare* fruiting bodies – the cause of *Heterobasidion* root disease.

Table 8-1C: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for *Heterobasidion* Root Disease (*Heterobasidion irregulare*)

BUTTERNUT CANKER (*Sirococcus clavignenti-juglandacearum*)
TREE SPECIES AFFECTED: BUTTERNUT

• **Prevention**

- Do not bring diseased butternut wood or bark in close proximity to any healthy butternut trees.

• **Early Detection**

- Look for elliptical cankers oftentimes oozing dark-colored liquid on root flares, main stems or branches.

• **Control and Management**

- Encourage regeneration of potentially resistant butternut: 1) Retain all butternut trees with more than 70 percent live crown and less than 20 percent of the combined circumference of the bole and root flares affected by cankers. 2) Retain all butternuts with at least 50 percent live crown and no cankers on the bole or root flares.
- Currently no individuals are known to have canker resistance. A few healthy butternut trees have been found growing among diseased and dying trees and may be resistant to the disease.
- Cut butternut trees with less than 70 percent live crown and more than 20 percent of the combined circumference of the bole and root flares affected by cankers.

• **Monitoring**

- Following control and management, monitor competition for sunlight from other trees and shrubs. Some vegetation management may be needed to allow sunlight to reach butternut seedlings growing under potentially resistant trees.

• **Restoration**

- See “Control and Management.”



(WDNR, Jane Cummings Carlson)

Figure 8-15: A butternut tree that is infected with *Sirococcus clavignenti-juglandacearum*, the cause of butternut canker.

Table 8-1D: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Butternut Canker (*Sirococcus clavignenti-juglandacearum*)

BEECH BARK DISEASE COMPLEX
(*Cryptococcus fagisuga* and *Neonectria* spp.)
TREE SPECIES AFFECTED: AMERICAN BEECH

- **Prevention**

- Do not bring beech wood or bark in close proximity to healthy beech.

- **Early Detection**

- Newly infested trees will have tiny spots or patches of “white wool” tucked into rough areas of bark on the trunk. These are the scales that cause the wounds that allow entry of the *Neonectria* fungi. As the scale population builds, the entire trunk and large branches of the tree can become covered with white wool.
- Tarry spots are often an early symptom of trees infected by *Neonectria*. Tarry spots occur when a brownish fluid oozes from a dead spot on the trunk.

- **Control and Management**

- Management options are largely based on the disease status of the forest and the percent of beech present. Detailed guidance can be found at: dnr.wi.gov – keywords “*beech bark disease*.”
- This disease typically causes infected trees to fail, break or “snap.” This can cause a hazardous situation if failure threatens to injure people or property. Remove these hazard trees promptly when scales are found.

- **Monitoring**

- A small percentage of American beech are resistant to the scale that makes infection by the disease possible. Report beech that are free of scales when surrounding beech are infested to a forest health specialist so that these resistant trees may be included in breeding programs to develop resistant beech for restoration of this species. Contact information for forest health specialists can be found at: dnr.wi.gov – keywords “*forest health staff*.”

- **Restoration**

- Retain any beech that are free of scales when surrounding trees are infested. These are resistant trees.



Figure 8-16: An American beech with black tar-like spot (sign of fungal canker) and beech scale (white fluffy substance).

Table 8-1E: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Beech Bark Disease Complex (*Cryptococcus fagisuga* and *Neonectria* spp.)

EUROPEAN GYPSY MOTH (*Lymantria dispar*) TREE SPECIES AFFECTED: OAK

• Prevention

- As of 2017, gypsy moth is still not established in counties on the far western side of Wisconsin. A Slow the Spread (STS) program uses traps to detect outlying populations which are then treated to prevent westward spread of the invasive pest. A quarantine has also been established to limit the spread of gypsy moth. For more information on the STS and aerial spray programs, the current range of gypsy moth in Wisconsin, or a map of the areas under quarantine, go to gypsymoth.wi.gov.
- Gypsy moth is often moved as egg masses on firewood, outdoor furnishings or vehicles stored outdoors. To avoid importing gypsy moth to your property, obtain firewood close to where you will use it and check outdoor items and vehicles stored outdoors for egg masses. Remove the egg masses before moving these items from areas where gypsy moth is established. Homeowners can go to: datcp.wi.gov/Pages/Programs_Services/GMPvtCitizen.aspx for instructions and a checklist for self-inspection to ensure you are complying with regulations to prevent the spread of gypsy moth.

• Early Detection

- Look for tan-colored egg masses left behind by the female moths. The egg masses are the size of a nickel or quarter, and are covered with thousands of tiny, fuzzy hairs. Old egg masses that hatched last spring are soft, pale and not a concern. Egg masses can be found on tree trunks and the underside of branches, as well as on buildings, firewood, vehicles, play sets, and other outdoor objects.
- Gypsy moth caterpillars change appearance as they grow. Young caterpillars are black or brown and about 1/4" in length. Mature caterpillars can be as long as 2-1/2" and have distinctive pairs of blue and red dots running down their backs.
- Gypsy moth adults are seen only in mid-summer. Males are grayish brown and can fly; females are white and cannot fly.
- If you find gypsy moth in the far western counties of the state, outside of the quarantined area, report them to: gypsymoth@wisconsin.gov. Include electronic images with your report.

(Continued on page 8-16)



Figure 8-17: Gypsy moth caterpillar.

Table 8-1F: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for European Gypsy Moth (*Lymantria dispar*) (continued on page 8-16)

EUROPEAN GYPSY MOTH (*Lymantria dispar*) (continued)

TREE SPECIES AFFECTED: OAK

• Control and Management

- Gypsy moth only causes significant defoliation during intermittent outbreaks when the population increases to very high numbers. In most of the state, outbreaks may occur about every 10 years. In stands of oak on dry, sandy soils, outbreaks may cycle more frequently, about every five years. In Wisconsin, most outbreaks last only a single season. Introduced fungal or viral diseases typically cause the collapse of an outbreak population.
- Healthy, vigorous trees can typically weather defoliation, and grow a second set of leaves in early July. Stressed or suppressed trees may not be able to recover. Such a natural thinning can benefit a forest by removing these unproductive trees and making the resources they had been consuming available to the survivors. For this reason, control of the damage gypsy moth does is most economically accomplished by maintaining a vigorous stand that can withstand the stress of defoliation. For silvicultural guidance relevant to management of gypsy moth, see *Managing Gypsy Moth in Forests or Woodlots* at: gypsymoth.wi.gov/.
- Thinning a stand causes stress to residual trees and if coincident with defoliation can lead to significant mortality. Conduct egg mass surveys the fall prior to thinning oak dominated stands and delay thinning if population of the pest is high enough to threaten defoliation of the stand. After defoliation, delay thinning for a year or two until trees regain vigor.
- If necessary, gypsy moth defoliation can be prevented over large areas using aerially applied insecticide. Guidance on how to arrange for an aerial spray is available at: gypsymoth.wi.gov.

• Monitoring

- The number of egg masses per acre present by late summer can help predict the expected level of defoliation the following spring. Predictive surveys don't need to be done every year; only in stands and in years where you would need to take an action such as delaying a thinning. Directions on how to conduct a predictive survey are available under *How to Predict Next Year's Damage* at: gypsymoth.wi.gov.

• Restoration

- Dead trees may be salvaged for financial value, or may be left for wildlife habitat. Assess the level of mortality and work with your forester to implement actions that may improve the vigor of residual trees and maintain a productive and sustainable forest.



Figure 8-18: Female adult gypsy moth, egg mass and pupal case.

Table 8-1F: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for European Gypsy Moth *Lymantria dispar* (continued from page 8-15)

CONIFER BARK BEETLE (*Ips* spp. and *Dedroctonus* spp.)

TREE SPECIES AFFECTED: CONIFERS

• Monitoring

- Look for individual trees or pockets of dying and dead conifers with small exit holes, pitch tubes on the bark, and/or bark beetle galleries under the bark of the tree(s).
- Fine reddish brown boring dust can be found in bark crevices, at the base of the tree, on understory broadleaf plants, and/or in spider webs.
- Watch for tree crowns fading from green to light green to straw yellow to red to brown.

• Prevention, Control and Management

- If the conifer stand is overstocked, thin to maintain a vigorous and healthy growing condition. Healthy conifers are able to resist bark beetles.
- If trees have low vigor due to drought or defoliation, consider a pre-salvage harvest, following guidelines for removal of breeding material.
- Promptly salvage or destroy potential bark beetle breeding material (including logs and tops down to 2" in diameter), such as trees that are severely damaged by wind, lightning, fire, disease, insects, or other destructive agents.
- Thin between September 1 and April 30. During harvest remove cut logs and tops down to 2" in diameter from the site by May 1 (if cutting during the winter) or within three weeks if cut from May 1 to August 31.

- Smaller branches that are left on the site should be left attached to stem wood to speed drying or if possible have the logging debris/slash scattered into openings to aid in drying out the material.
- Minimize the damage to crop trees during logging operations. When thinning, use the lightest suitable equipment to minimize soil compaction and root injury. Wounds to the trees and/or roots especially during hot, dry weather, attract bark beetles.
- Use the conifer species and spacing intervals best suited to that site to minimize site related stressors.

• Restoration

- Needs and options will be site specific.



(Scott Tunnock, USDA Forest Service, Bugwood.org)

Figure 8-19: Bark beetle feeding gallery and adults.

Table 8-1G: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Conifer Bark Beetle (*Ips* spp. and *Dedroctonus* spp.)

EMERALD ASH BORER (*Agrilus planipennis*)

TREE SPECIES AFFECTED: ASH

• Prevention

- Be aware of if emerald ash borer (EAB) has been confirmed in your community. A current map of the municipalities where EAB has been confirmed can be found at: emeraldashborer.wi.gov.
- If your property is away from municipalities where it has been confirmed, take precautions to avoid introducing it. If you use firewood on the property, obtain it from a nearby source. EAB is easily moved in firewood.
- If EAB has been confirmed in your municipality, take precautions to avoid spreading EAB to un-infested areas. Regulations on Transport, Utilization and Disposal of Ash Wood and Voluntary Recommendations to Reduce Spread of EAB in Potentially Infested Wood can be found at: emeraldashborer.wi.gov.

• Early Detection

- Become familiar with the symptoms and signs of EAB and EAB look-alikes. Information on identifying EAB and its damage can be found at: emeraldashborer.wi.gov under the tab “Report EAB.” If you suspect you have found a new EAB infestation please report it at the above website and include an electronic image. Typically, EAB infestations are difficult to spot until they have been established for four to five years.

• Control and Management

- As of 2017, there are no practical insecticide treatments for woodlots to control EAB. Consult emeraldashborer.wi.gov for the latest advances in the management of EAB.
- There are pesticide treatments to preserve individual, high-value trees if applied soon after infestation, before noticeable thinning or dieback has occurred.



Figure 8-20: Emerald ash borer larvae in serpentine feeding galleries.

- Discuss silvicultural options with your forester to reduce losses and impact to the sustainability of your forest. Management plans may need to be updated taking into account EAB.
 - Practice sustainable forestry. Removing all ash prior to EAB establishment in the local area is not recommended but, if stands contain greater than 20 percent ash, the amount of ash could be reduced through thinning to minimize future financial losses from EAB.
 - Contact Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) regulatory staff for intrastate movement and USDA Animal Plant Health Inspection Service (APHIS) staff for interstate movement.
- #### • Restoration
- Needs and options for restoration will be site specific. Stands with a high proportion of ash may be more susceptible to takeover by invasive plants, and may require control of the invasive plants and planting of desirable tree species. Forests with minimal ash and high species diversity will be better able to recover following the mortality of the ash without additional management.

Table 8-1H: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Emerald Ash Borer (*Agrilus planipennis*)

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

BEST MANAGEMENT PRACTICES FOR INVASIVE SPECIES

The Wisconsin Council on Forestry website includes Best Management Practices of Invasive Species for:

- Forestry
- Recreational Users
- Urban Forestry
- Right-of-Way Management

www.wisconsinforestry.org

UNIVERSITY OF WISCONSIN DEPARTMENT OF PLANT PATHOLOGY

The University of Wisconsin Department of Plant Pathology website provides access to publications on many common diseases of trees. This website also has instructions for submitting a plant disease sample for diagnosis.

pddc.wisc.edu

UNIVERSITY OF WISCONSIN INSECT IDENTIFICATION LAB

Electronic images or physical samples may be submitted for identification to the University of Wisconsin Insect Identification Lab.

labs.russell.wisc.edu/insectlab

WISCONSIN DNR FOREST HEALTH RESOURCES

- Forest health specialists are located around the state to assist foresters, forest landowners and property managers with identifying causes of forest health issues and give technical guidance on returning forests to full health and productivity. Contact information for regional forest health staff can be found at the Wisconsin DNR forest health staff page.

dnr.wi.gov – keywords “forest health staff”

- The Wisconsin DNR Forest Health webpages contain up-to-date management guidance for many of the most damaging pests, diseases and invasive plants in Wisconsin.

dnr.wi.gov – keywords “forest health”

- The DNR Forest Health staff post regular newsletters that landowners can subscribe to that provide information on developing pest, disease and invasive plant issues. To subscribe, you can visit:

forestrynews.blogs.govdelivery.com/category/forest-health-news.

WISCONSIN'S EMERALD ASH BORER INFORMATION SOURCE

The Wisconsin state emerald ash borer website provides a one-stop site for information on the distribution, identification of signs and symptoms, management options, and quarantine regulations for emerald ash borer.

emeraldashborer.wi.gov

WISCONSIN'S GYPSY MOTH INFORMATION WEBSITE

Information on the distribution, quarantine regulations, state spray treatments, identification, monitoring, and management options for gypsy moth in Wisconsin can be found at the states informational website.

gypsymoth.wi.gov