A man wearing a blue hard hat and a light-colored short-sleeved shirt is using a red-handled tool to clear vegetation. He is standing next to a yellow tracked vehicle with a large yellow mesh grille. The background shows a dense forest of tall trees.

**CHAPTER 8**  
**Invasive Plants,**  
**Insects and Diseases**

## CHAPTER 8 INVASIVE PLANTS, INSECTS AND DISEASES

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## WHAT ARE INVASIVE SPECIES?

Plants, insects and disease-causing organisms are considered **invasive** if they can cause harm to the economy, ecosystem or to human health. Invasive species thrive if they are able to establish, tolerate a wide range of environmental conditions, and disperse. Non-native invasive species are often not limited by the diseases, predators, and parasites that keep their populations in check in their native range. For the purpose of this document, **invasive plants will always refer to non-native plants unless specifically mentioned. Invasive insects will include native and non-native insects; invasive diseases will include native and non-native disease-causing organisms** (e.g., fungi, bacteria, viruses, phytoplasmas).

Some non-native invasive species have been introduced intentionally for a variety of reasons, including for:

- food (e.g., agriculture crops and livestock)
- erosion control (e.g., reed canary grass)
- gardening (e.g., Japanese barberry, purple loosestrife)
- shade trees (e.g., Norway maple)
- sport fishing (e.g., earthworms, carp, brown trout, rainbow trout, salmon)
- game animals (e.g., ring-necked pheasant)

Unintentional introductions of invasive species to forests in eastern North America are increasing due to an increase in international trade.



Figure 8-1: Japanese barberry for sale at a nursery.

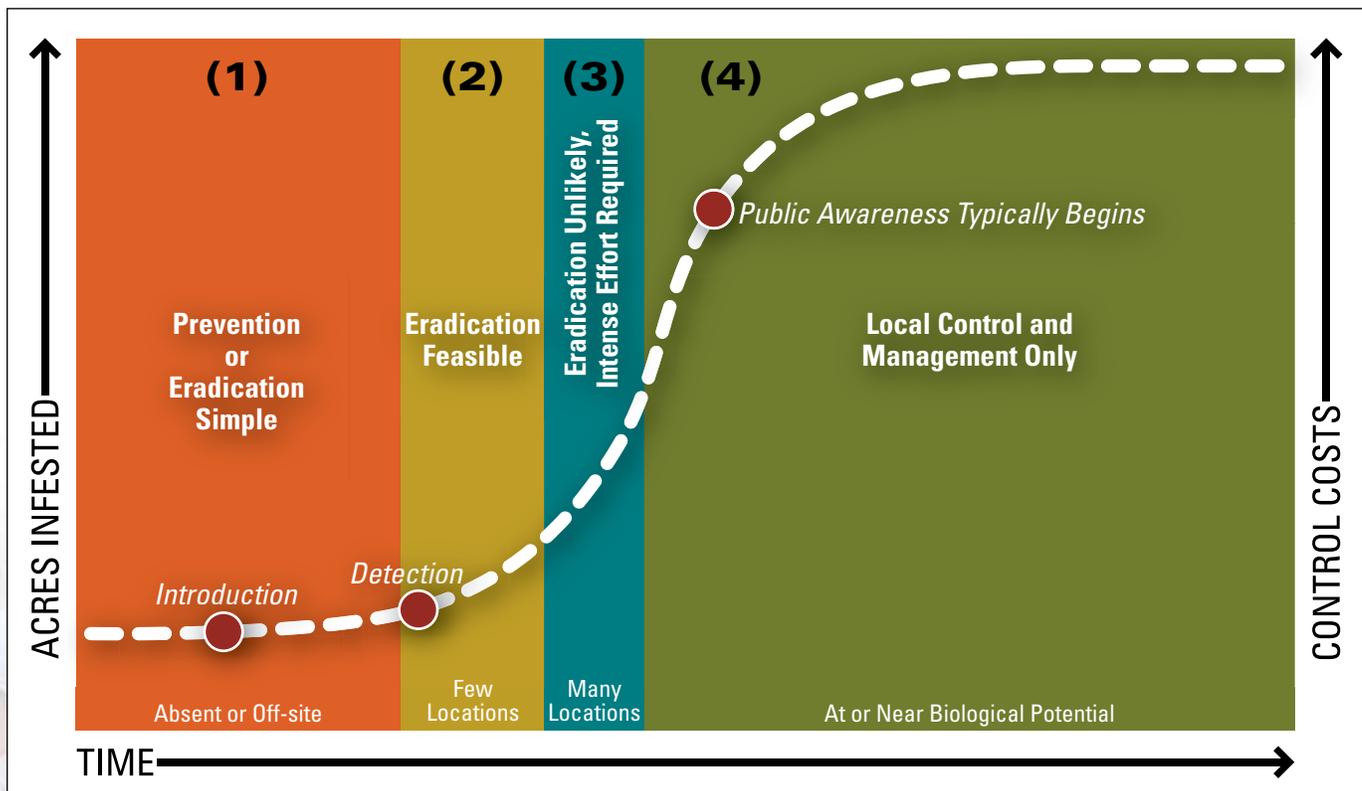


Figure 8-2: Japanese barberry invading a woodland.

Invasive species pose threats to habitats and economies in areas as diverse as agriculture, forestry, livestock, fisheries, and recreation. Invasive species are causing dramatic changes in many ecosystems worldwide and along with habitat alteration have resulted in native and rare species declines. Local, state, tribal, and national governments; public agencies; non-profit organizations; private corporations; and individual landowners have begun to recognize the invasive species threat and are taking steps to address the problem.

One of the most difficult aspects of managing invasive species is that they are usually widespread before they are recognized as harmful.

- Some species, like small insects or fungi, are so inconspicuous that populations go unnoticed for many years after introduction.
- Others species are non-invasive at first, but become invasive later due to adaptation, because wildlife begin to spread them (e.g., multiflora rose), or as population sizes reach the point where exponential growth allows them to increase rapidly.



*Figure 8-3: 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 simple. 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 invasive characteristics. The second phase (2) has a few populations and eradication is still feasible. If an invasive species is detected early, when it is only found in a few locations before the population has entered the exponential growth phase, it may be possible to eradicate it. The third phase (3) has many more populations and eradication is unlikely and requires intense effort. The fourth phase (4) is where the population is at or near its biological potential and local control and management is the only option. The goal is to keep a species in phases 1 through 3 and have the public awareness point on the curve drop.*

*(Figure Credit: The Nature Conservancy, John Randall)*

## INVASIVE SPECIES ARE A THREAT TO FORESTS

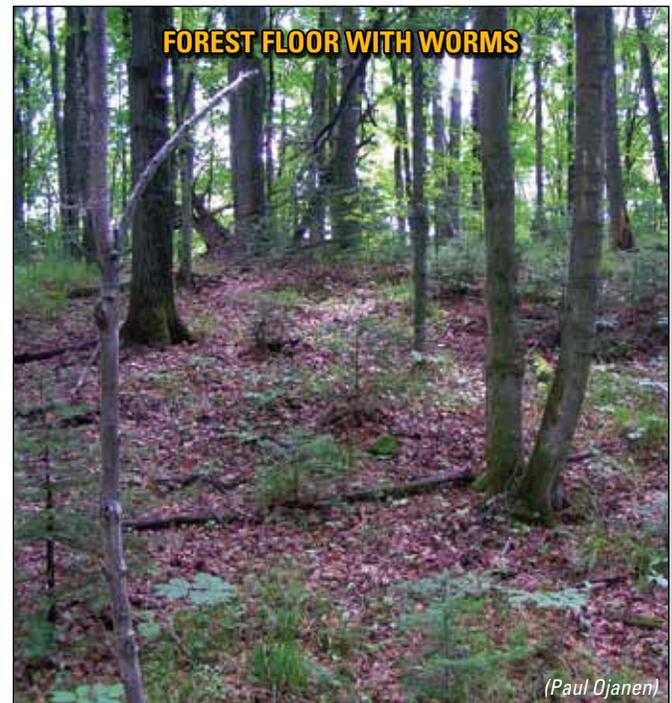
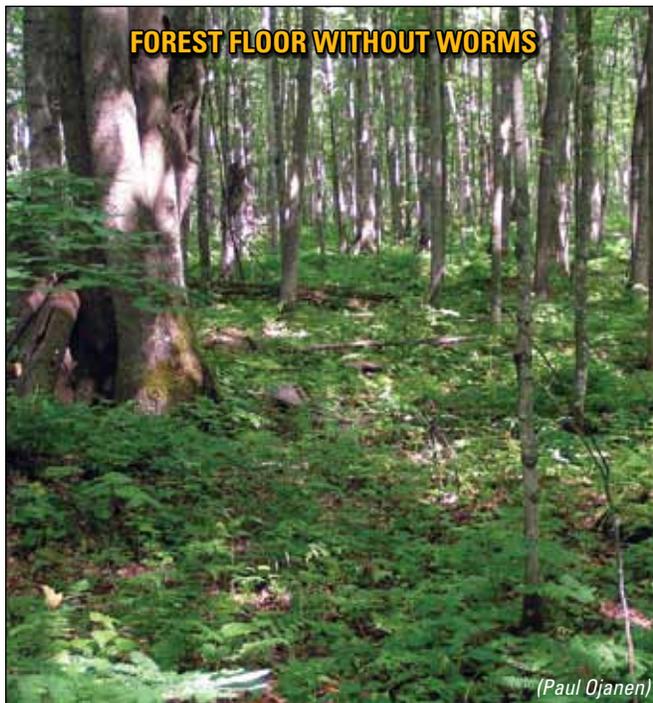


Figure 8-4: Non-native earthworms alter soil chemistry and impact tree generation.

Invasive insects and diseases have had a significant, negative impact on several commercially important tree species resulting in widespread mortality in some and a reduction in growth in others. Examples include the American chestnut (*Castanea dentata*), once one of the most abundant tree species in eastern U.S. hardwood forests and one of high economic importance. In the early 1900s, chestnut blight, caused by the fungus *Cryphonectria parasitica*, was accidentally introduced from Asia, and within 40 years, few chestnut trees remained. Although chestnut trees re-sprout, the blight continues to attack the sprouts, preventing the tree from regaining its former status.

Gypsy moth (*Lymantria dispar*), originally from Europe, Asia, and North Africa, was accidentally released in Massachusetts in 1867 in a failed attempt to raise a hardy silkworm. The larvae now defoliate approximately one million acres of oak and aspen forest annually from Maine to Virginia, and west to Wisconsin. While gypsy moth has not caused significant mortality, it is an additional stressor that slows growth and often contributes to mortality in trees that have been weakened by previous defoliation, or other stressors such as drought. Native invasive organisms have coevolved with their hosts, increasing the probability

that some of the hosts will be resistant or that natural enemies (parasites and predators) will play a more significant role in moderating the population of the insect or disease-causing organism. Yet even with coevolution, native invasive species, such as the forest tent caterpillar (*Malacosoma disstria*) can cause decline in tree growth rates and in some cases tree mortality, particularly when coupled with other stressors such as drought or other defoliators. Thus, elements of invasive species management should be considered with both non-native and native invasive insects and diseases.

Invasive species can also have a direct impact on forestry by potentially reducing tree regeneration, growth, and longevity. For example, researchers have documented common buckthorn (*Rhamnus cathartica*) and non-native earthworms alter the chemistry of forest soils and consequently impact tree regeneration and growth (Bohlen et al. 2004, Heneghan et al. 2004, 2006). Garlic mustard (*Alliaria petiolata*) appears to suppress tree regeneration by disrupting beneficial associations between tree seedling roots and fungi (mycorrhizal associations), which may help explain its ability to invade undisturbed sites (Stinson et al. 2006).

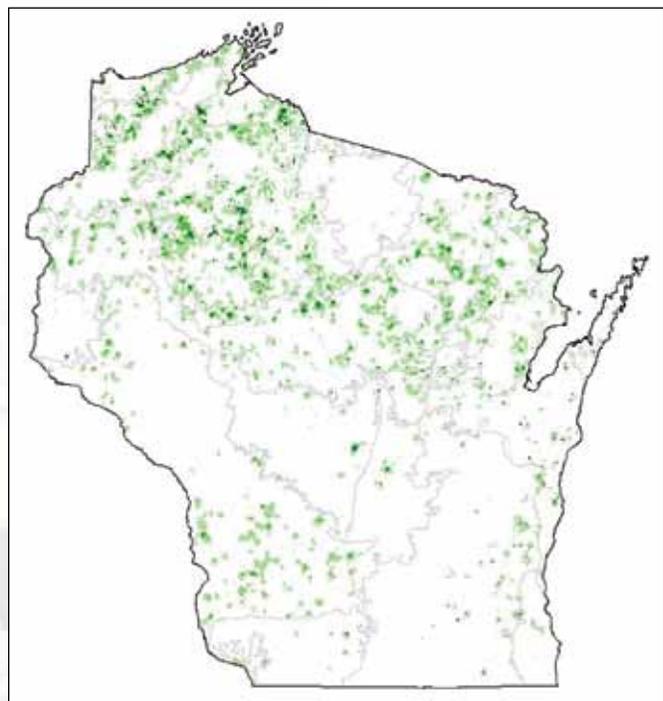
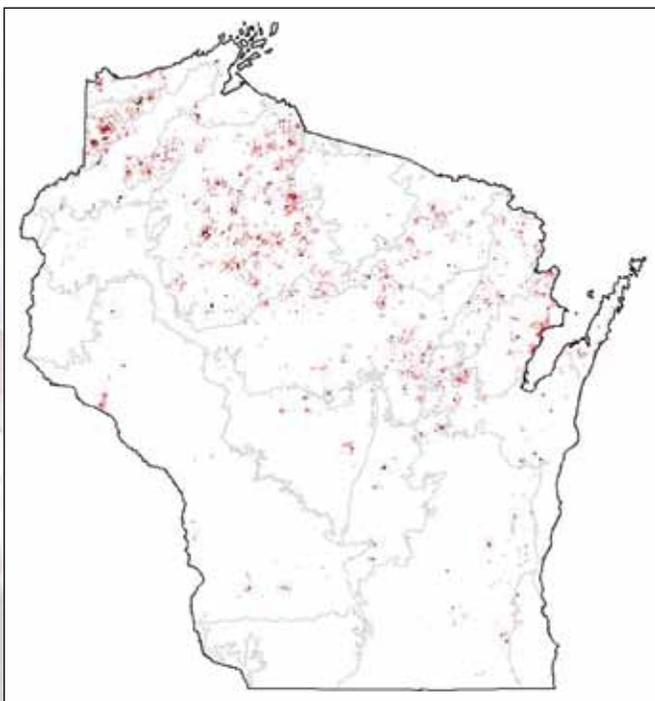
## INVASIVE SPECIES MAY ALTER FOREST STEWARDSHIP

Depending on the invasive species present, its abundance, site conditions, and other factors, a landowner's forest stewardship objectives may be affected. For example, emerald ash borer (EAB), an exotic wood-boring beetle that attacks ash trees, was found in Michigan in 2002. By August 2008, it was found in 10 additional states, including Wisconsin. (For an up-to-date map showing EAB distribution, go to [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov) and click on 'Where has EAB been found.')

The borer has had a significant impact, causing mortality of ash in urban and rural forests. The borer is expected to eventually spread throughout forested lands in Wisconsin, threatening all native ash species. Consequently, forest composition objectives that include ash species are being revised. This is an extreme example of how the arrival of a non-native invasive species can alter management plans.



*Figure 8-5: The garlic mustard that dominates the understory in this stand will greatly impact forest stewardship. Garlic mustard suppresses tree regeneration by disrupting the beneficial association between tree seedling roots and fungi.*



*Figure 8-6: Black ash distribution (left) and white and green ash distribution (right) in Wisconsin based on 1996 Forest Inventory Analysis data, <http://dnr.wi.gov/forestry/fh/ash/eab-impact.htm>.*

## FORESTRY PRACTICES CAN INFLUENCE THE SPREAD OF INVASIVE SPECIES

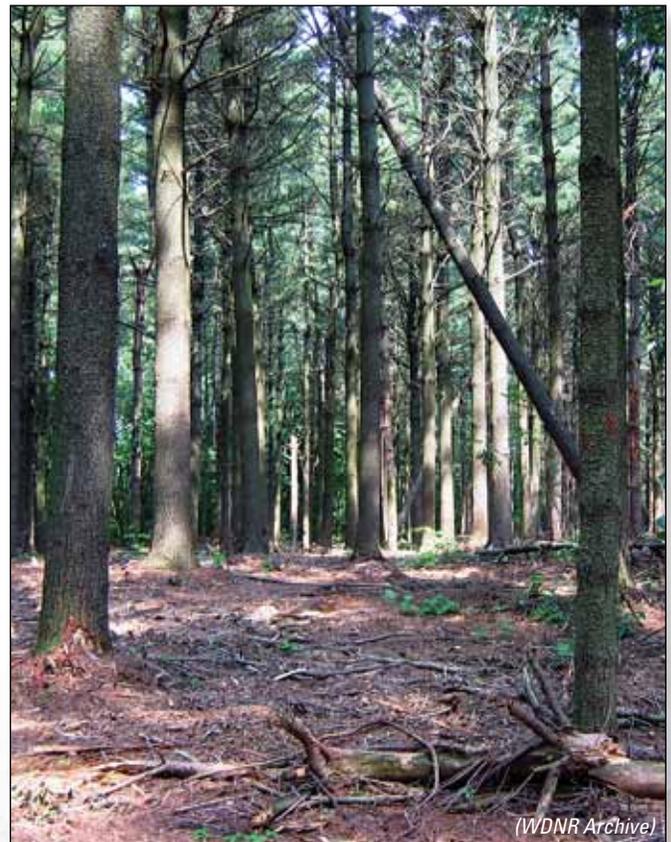
Forest stewardship (management) activities can create site conditions suitable for many opportunistic invasive species. These conditions can occur through site disturbance that exposes soil and creates a seedbed for invasive plants, or by releasing invasive plant seeds that are already present. Forest stewardship activities may also increase the likelihood of invasive propagules being accidentally introduced to a site.

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



*Figure 8-8: The brushing activity has created an excellent bed for invasive plants to grow in. It is important to understand the species that were removed as well as those that are nearby, in order to plan for the future regrowth.*

## ELEMENTS OF INVASIVE SPECIES MANAGEMENT

Invasive species management programs across the country (including the U.S. Forest Service) have widely incorporated several common elements: prevention, early detection and rapid response, control, monitoring, and restoration. These elements can help guide or inform landowners and land managers who are concerned about invasive species on their land. Tables 8-1A through 1H (see pages 8-9 through 8-18) provide a list of some invasive insects and diseases and some key information related to management.

### Prevention

An effective, economical, and ecologically sound approach to managing invasive species is to prevent their introduction in the first place because once a population becomes established, management can be expensive and may further damage ecological systems; in many cases, eradication may be impossible. As a result, invasive species prevention practices should be identified in the project planning stage. For example, the impact of white pine blister rust (a disease of white pine) can be minimized through selection of planting sites that are not conducive to disease development, control of *Ribes* spp. (the alternate host for this disease) and pruning of white pine to eliminate lower branches – which are most susceptible to infection.

### Early Detection and Rapid Response

The chances for eradication or containment (control) of an invasive species are greatest immediately after their introduction. Therefore, early detection and rapid response plays an important part in managing invasive species.

Early detection, as applied to invasive species, is a comprehensive, integrated system of active or passive surveillance to find new populations of invasive species as early as possible, when eradication and containment (control) are still feasible and less costly. It may be targeted at three specific areas:

- areas where introductions are likely, such as access points and travel corridors

- areas with high ecological value where impacts are likely to be significant
- vulnerable habitats or recently disturbed areas

Rapid response is a systematic effort to eradicate, control, or contain invasive species while the infestation is still localized. It may be implemented in response to new introductions or to isolated infestations of a previously established species. Preliminary assessment and subsequent monitoring may be part of the response. It is most effective when based on a plan organized in advance so that the response is rapid and efficient.

### Control

The site level eradication of some invasive populations is an attainable goal especially if new introductions are detected early. However, eradication may not be feasible when populations are large and pervasive. When limited resources or the degree of infestation preclude eradication, more realistic management goals may be to control the unwanted species. Containing an infestation within a defined geographical area can be very effective at slowing its spread regionally or reducing the impact of invasive species by reducing their density and abundance to a level which, ideally, does not compromise the integrity of the ecosystem and allows native species to thrive.

- Control programs are usually ongoing and can include manual, mechanical, chemical, biological, and cultural components.
- Landowners and land managers should evaluate their site, the life cycle characteristics of the invasive species, and the best available science to determine which control method or combination of methods will be most effective and economical. Impacts of control methods on ecological systems also should be evaluated.
- Control programs should be integrated in ways that maximize management objectives, while minimizing negative environmental impacts.



(Elizabeth Czarapata)

*Figure 8-9: Black swallow-wort is a fast-growing vine that will climb trees and shrubs and ultimately shade out the understory. There are only a few known populations in Wisconsin, so early detection of the plant is critical. Once identified, it should be controlled quickly to prevent its rapid spread.*

## Monitoring

Monitoring is the periodic inspection of post-activity sites to detect new invasions and evaluate the success of pest management plans and control measures. Most landowners and land managers will not need complex monitoring programs.

- Monitoring can be integrated with other forest activities such as reforestation surveys.
- Monitoring should be kept as simple as possible to meet invasive species management objectives.
- A simple monitoring program should identify target areas to visit and a list of prioritized invasive species one is likely to encounter. Target areas can include areas that are susceptible to invasion, such as transportation corridors and recently disturbed areas, and/or previous infestations that have undergone control measures.
- Periodic visits to these areas will allow landowners and land managers to detect new invasions and assess the success of their control efforts.

Revised 2011



(WDNR, Thomas Boos)

*Figure 8-10: Girdled ash trees are used to detect the presence of emerald ash borer. These trees emit chemicals that attract the insect.*

## Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecosystems that require restoration may have been altered by natural occurrences like wildfire, floods, or storms, or as the result of human activities, including the intentional or unintentional introduction of invasive species.

- In the simplest circumstances, restoration can consist of removing or modifying a specific disturbance.
- In other circumstances, restoration may also require the deliberate reintroduction of native species that have been lost and the elimination or control of harmful, invasive non-native species to the extent possible.
- Restoring native plant communities to a site that has been cleared of invasives may reduce the risk of future invasions and in the long run the need for active control.

## IMPLEMENTING INVASIVE INSECT AND DISEASE MANAGEMENT

Each invasive insect or organism that causes disease will have a life cycle that makes it unique. Implementing management requires an understanding of the invasive specie's life cycle or method of infection, reproduction and spread. Interrupting the life cycle is key to managing these species. There is no one source of information on all invasive species yet technical information on the biology and management of the

most destructive species is available through a variety of resources. The following tables (Tables 8-1A through 8-1H) lists some of the most common and threatening invasive insects and diseases affecting Wisconsin's forests and key management considerations. For more comprehensive information, check the resources listed at the end of this chapter.

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

#### PREVENTION (IF CONDITIONS ARE FAVORABLE FOR BLISTER RUST)

- Plant two rows of a coniferous species, such as spruce, around a white pine planting. The spruce will help to disrupt the movement of infectious spores from *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 the most desirable individuals and trees on the outside rows – bordering areas where there are *Ribes* plants. 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.
- Plant species that are not susceptible, but are suitable for the site.

#### EARLY DETECTION; SCOUT FOR

- Flagging (dying branches with brown foliage) branches, particularly in lower 9' of stem.
- Areas of rough, dark bark where stem may be constricted and oozing pitch.
- Yellow to orange blisters on branches or the trunk in spring.

#### CONTROL AND MANAGEMENT

- Trees with blister rust cankers on the main stem or within 4" of the main stem cannot be saved, do not waste your time pruning them.
- 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 reinfest *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.



Figure 8-11: Bleeding canker caused by the fungus *Cronartium ribicola*; white pine blister rust.

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

## 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, **or do not prune after daytime temperatures reach 50°F even if it is still March.** Infections can occur after July but are rare. To take a very cautious approach, do not prune or otherwise wound oaks from April to October.

**Forested Setting:** For more information, refer to *Oak Wilt: Harvest Guidelines for Reducing the Risk of Introduction and Spread in a Forest Setting* at [www.dnr.state.wi.us/forestry/fh/oakWilt/guidelines.asp](http://www.dnr.state.wi.us/forestry/fh/oakWilt/guidelines.asp).

#### EARLY DETECTION; SCOUT FOR

**Red Oak Group:** 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.



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

Table 8-1B: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Oak Wilt (continued on page 8-11)

## OAK WILT (*Ceratocystis fagacearum*)

### TREE SPECIES AFFECTED: OAK

#### 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 an oak wilt management specialist.

**Overland Spread:** If healthy trees are wounded during the high risk period of April through June in urban areas, the wounds should be treated with a tree-wound paint to prevent sap-feeding beetles from feeding on them.

Trees that have died from oak wilt can harbor the fungal mats, so if this wood is moved, the fungal mats are moved and the disease may spread into unaffected areas. **Any trees that have died from oak wilt and have bark that is tightly attached to the wood could harbor fungal mats.** This wood must receive special treatment (see “Firewood” and “Other Wood Products”) before moving. Once the bark has become loose and falls off the wood, the mats are no longer viable. 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) the wood will prevent the fungal mats from forming. Debarking must be conducted before fungal mats form, thus it should occur in the late summer, fall or winter following tree death.
- Cutting, splitting, stacking and covering the wood with 4mm 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, stones, or other heavy objects. 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; the infected trees with tightly attached bark must be utilized before April 1.

Oak wilt fungal mats does not survive well when they are dried out or is growing where other wood decay fungi are present. Thus, wood chips from infected trees are **highly unlikely** to serve as a source of spores and can be used for landscaping.

#### MONITORING; SCOUT 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 (continued from page 8-10)*

**ANNOSUM ROOT ROT (*Heterobasidion irregulare*)**  
**TREE SPECIES AFFECTED: MOST COMMONLY OBSERVED ON RED AND WHITE PINE**  
**PLANTATION-GROWN TREES IN WISCONSIN**

**PREVENTION**

Prevention of Annosum root rot is the most important approach to management. Treat freshly cut stumps (during thinnings) with a product registered to prevent this disease. For detailed information on registered products, consult <http://dnr.wi.gov/forestry/Fh/annosum/>.

**EARLY DETECTION; SCOUT FOR**

- Conifers with thin crowns, reduced height, diameter and shoot growth. Individual or pockets of dead and dying pine or spruce including overstory and understory. Crown symptoms typically appear two to three years after a thinning or partial harvest where stumps are left among living trees.
- Individual or pockets of dead trees with fruit bodies at the root collar of dying or dead trees or stumps (may have to pull the duff layer back to see this).

**CONTROL AND MANAGEMENT**

Options for control and management are dependant on several factors. For detailed options, please consult <http://dnr.wi.gov/forestry/Fh/annosum/>.

**MONITORING**

See “Early Detection.”

**RESTORATION**

- This fungus can survive for decades in the soil. Expect some further mortality to occur to susceptible species when attempting regeneration. Some deciduous trees are susceptible but tend to sustain lower mortality; conversion to hardwoods, if appropriate for the site, should be considered.
- 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: Pine stump with *Heterobasidion irregulare* fruit bodies – the cause of Annosum root rot.

Table 8-1C: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Annosum Root Rot

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

**PREVENTION**

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

**EARLY DETECTION; SCOUT 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 butternut selections are available that have known canker resistance. A few healthy butternut trees have been found growing among diseased and dying trees and may be resistant to the disease.
- Remove from the stand 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. Destroy this diseased material as quickly as possible, and see “Prevention” above.

**MONITORING**

If 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 clavigignenti-juglandacearum*, the cause of butternut canker.*

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

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

**PREVENTION**

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

**EARLY DETECTION; SCOUT FOR**

- Newly infested trees will have tiny spots or patches of “white wool” tucked into rough areas of bark on the trunk. 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 beech present. For detailed guidance, consult <http://dnr.wi.gov/forestry/FH/bb.htm>.

**MONITORING**

- A small percentage of American beech may be resistant to this disease. Identify potentially resistant trees (trees that survive while others are dying) to your local Wisconsin DNR forest health specialist.



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

- 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.

**RESTORATION**

See “Control and Management.”

Table 8-1E: Invasive Insects and Diseases Affecting Wisconsin’s Forests and Key Management Considerations for Beech Bark Disease

**EUROPEAN GYPSY MOTH (*Lymantria dispar*)**  
**TREE SPECIES AFFECTED: OAK, BIRCH AND ASPEN ARE PREFERRED SPECIES**  
**THUS ARE TYPICALLY DEFOLIATED THE MOST**

**PREVENTION**

- To reduce the impact of an outbreak, reduce the proportion of preferred tree species to less than 50 percent of a stand. Favor the growth of non-preferred species.
- Utilize appropriate forest management strategies to improve tree vigor so that trees are more likely to survive if defoliated. If planning any type of harvest activity that could stress the residual trees, complete work two to three years before an expected defoliation or several years after defoliation to minimize the stress on the forest.

**EARLY DETECTION; SCOUT FOR**

- Gypsy moth is well-established in eastern and central Wisconsin. Report new detections in western Wisconsin to **1-800-642-MOTH**; [www.gypsymoth.wi.gov](http://www.gypsymoth.wi.gov).
- 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.

**CONTROL AND MANAGEMENT**

- Successful management of gypsy moth requires an integrated approach that includes several strategies. For more information, consult [www.gypsymoth.wi.gov](http://www.gypsymoth.wi.gov).
- When population densities are high or in outbreak situations, an approach for preventing widespread defoliation and reducing the population is aerial application of a biologically derived insecticide called *Bacillus thuringiensis* var. kurstaki, commonly known as Bt. Insecticide treatments can also be applied to individual trees when an infestation is small. The Wisconsin DNR offers a county-administered aerial suppression program for landowners and local governments. The deadline for counties to apply to the Wisconsin DNR Gypsy Moth Suppression Program is in early December, so contact the municipal or county government as soon as practical after Labor Day to determine if your county is participating.
- Two biological control organisms are present in Wisconsin and may play a significant role in reducing populations of this insect. The fungus *Entomophoga maimaiga* and the nucleopolyhedrosis virus (NPV) are particularly effective at killing the larval stage when spring weather is cool and moist.

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

**EUROPEAN GYPSY MOTH (*Lymantria dispar*)**  
**TREE SPECIES AFFECTED: OAK, BIRCH AND ASPEN ARE PREFERRED SPECIES**  
**THUS ARE TYPICALLY DEFOLIATED THE MOST**

**MONITORING**

- Check for the presence of caterpillars, egg masses or adult females. Populations will fluctuate from year to year.
- After defoliation, monitor for dieback and mortality of oak, birch and aspen. Consult with your forester if extensive dieback or mortality is observed to plan for salvage or mitigation options.

**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 sustainable forest.



(WDNR, Bill McNee)

Figure 8-17: Gypsy moth caterpillar.



(WDNR, Bill McNee)

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 (continued from page 8-15)

## CONIFER BARK BEETLE (*Ips* spp., *Dedroctonus* spp.) TREE SPECIES AFFECTED: CONIFERS

### EARLY DETECTION/MONITORING; SCOUT FOR:

- An individual tree 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.
- 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.
- 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

## EMERALD ASH BORER (EAB) (*Agrilus planipennis*)

### TREE SPECIES AFFECTED: ASH

#### PREVENTION

- Consult [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov).
- Reduce the proportion of ash during regularly scheduled stand entries if the stand is greater than 20 percent ash.
- Do not move ash material (firewood, nursery stock, logs) onto property.
- Inventory the trees on your property to identify your ash resource, determine the potential impact of EAB and develop a plan of action.
- Consult with a professional forester to determine your options for minimizing the impact of EAB.
- Consider using pesticides to prevent infestation of high value trees (typically only in urban settings).

#### EARLY DETECTION

Become familiar with the symptoms and signs of EAB and EAB look a-likes. Report suspect infestations to the EAB hotline **1-800-462-2803** or email **DATCP EmeraldAshBorer@wisconsin.gov**. Typically, EAB infestations are difficult to spot until they have been established for four to five years.

#### CONTROL AND MANAGEMENT

- Consult [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov) to become familiar with EAB quarantine regulations and forest management options.
- Destroy or utilize infested material by following guidelines for managing EAB-infested wood.
- If planning on moving regulated material out of a quarantined area, follow quarantine regulations and 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.

- Consider using pesticides to maintain high value trees (typically urban settings) and reduce EAB populations within the tree. This is currently recommended only if the trees are less than 10 to 12 miles from a known infestation.
- Contact a professional forester to review options for implementing management practices that sustain a forest resource on your property. Woodlot owners in quarantined counties should consult a forester to determine whether their management practices should change due to a known EAB infestation. This decision will depend on several factors, including distance from known EAB infestations, stand composition and age, management goals, and current markets for the wood. Practice sustainable forestry. Removing all ash prior to EAB establishment in the local area is not recommended.

#### RESTORATION

Needs and options for restoration will be site specific. Mixed forests, forests with minimal ash, and forests with high species diversity will be better able to recover following the mortality of the ash in that location. In general, there will be fewer restoration options on wet sites such as swamps and bottomlands. On many wet sites, invasive species such as reed canary grass take over gaps created by EAB mortality. Wet sites may be difficult to regenerate trees.



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

Table 8-1H: Invasive Insects and Diseases Affecting Wisconsin's Forests and Key Management Considerations for Emerald Ash Borer

## FORESTRY BMPs FOR INVASIVE SPECIES

Invasive Species Best Management Practices for Forestry were developed by the Wisconsin Council on Forestry in 2009. The Forestry BMPs for Invasive Species (IS-BMPs) 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*.

### 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.

## 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.*

### CENTER FOR INVASIVE PLANT MANAGEMENT

The Center for Invasive Plant Management (CIPM) web site provides information on invasive plant identification, biology, and impacts of invasive species. It also includes links to a resource guide, weed control methods, and invasive plant management online textbook.

[www.weedcenter.org](http://www.weedcenter.org)

### CHRISTMAS TREE PEST MANUAL

*Christmas Tree Pest Manual (Second Edition).*

McCullough, D. G., Katovich, S. A., Ostry, M. E. and Cummings Carlson, J. E., Michigan State University Extension Bulletin E-2676, 1998.

### DIRECTORY OF EXOTIC FOREST INSECT AND DISEASE PESTS

*Directory of Exotic Forest Insect and Disease Pests.*

McCullough, D. G. and Zablotny, J. E., Michigan State University Extension Bulletin E-2811, 2002.

### FORESTRY BEST MANAGEMENT PRACTICES FOR INVASIVE SPECIES, APPENDIX H

Appendix H in the *Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners, and Loggers* has an extensive lists of resources.

<http://council.wisconsinforestry.org/invasives/pdf/Appendix-H.pdf>

### GREAT LAKES INDIAN FISH AND WILDLIFE COMMISSION

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Exotic Plant Information Center's web site features a searchable database of invasive species accounts. It also provides distribution maps, educational materials, and a slide library.

[www.glifwc.org/invasives/](http://www.glifwc.org/invasives/)

### GYPSY MOTH IN WISCONSIN

The Wisconsin state gypsy moth web site provides information on biology and management of gypsy moth.

<http://fyi.uwex.edu/gypsymothinwisconsin/>

### INVASIVE PLANTS ASSOCIATION OF WISCONSIN

The mission of the Invasive Plants Association of Wisconsin (IPAW) is to promote better stewardship of the natural resources of Wisconsin by advancing the understanding of invasive plants and encouraging the control of their spread. Their web site offers a photo gallery, invasive species list, educational resources, news and events, and more.

[www.ipaw.org](http://www.ipaw.org)

### MIDWEST INVASIVE PLANT NETWORK

The mission of the Midwest Invasive Plant Network (MIPN) is to reduce the impact of invasive plant species in the Midwest. The web site provides information on prevention, early detection and rapid response, control and management, education, research, and more.

[www.mipn.org/](http://www.mipn.org/)

### NATIONAL INVASIVE SPECIES MANAGEMENT PLAN

The 2008-2012 National Invasive Species Management Plan (2008 Plan) directs Federal efforts (including overall strategy and objectives) to prevent, control and minimize invasive species and their impacts through 2012.

[www.invasivespecies.gov/main\\_nav/mn\\_NISC\\_ManagementPlan.html](http://www.invasivespecies.gov/main_nav/mn_NISC_ManagementPlan.html)

### NATURAL RESOURCES CANADA

The Natural Resources Canada web site provides a tool to help identify what may be causing injury to forest trees based on affected tree.

<http://imfc.cfl.scf.rncan.gc.ca/identification/identification1-eng.html>

### PLANT CONSERVATION ALLIANCE, WEEDS GONE WILD, ALIEN PLANT INVADERS OF NATURAL AREAS

The Plant Conservation Alliance (PCA) web site provides a list of invasive plants in the U.S., background information on the threats and impacts of invasive species, fact sheets, and relevant links.

[www.nps.gov/plants/alien/](http://www.nps.gov/plants/alien/)

### **UNIVERSITY OF WISCONSIN DEPARTMENT OF ENTOMOLOGY**

The University of Wisconsin Department of Entomology web site provides access to publications on many common insects that affect trees. This web site also has information on insect identification and instructions for submitting an insect specimen for identification.  
**[www.entomology.wisc.edu](http://www.entomology.wisc.edu)**

### **UNIVERSITY OF WISCONSIN DEPARTMENT OF PLANT PATHOLOGY**

The University of Wisconsin Department of Plant Pathology web site provides access to publications on many common diseases of trees. This web site also has instructions for submitting a plant disease sample for diagnosis.  
**<http://pddc.wisc.edu>**

### **USDA FOREST SERVICE FOREST HEALTH PROTECTION**

The USDA Forest Service forest health protection web site provides information on the status of several invasive species threatening the health of the forests of North America.  
**[www.na.fs.fed.us/fhp/index.shtm](http://www.na.fs.fed.us/fhp/index.shtm)**

### **USDA FOREST SERVICE INVASIVE SPECIES PROGRAM**

The U.S. Department of Agriculture Forest Service Invasive Species Program web site, a portal to Forest Service invasive species information and related management and research activities.  
**[www.fs.fed.us/invasivespecies/](http://www.fs.fed.us/invasivespecies/)**

### **WISCONSIN COUNCIL ON FORESTRY**

The Wisconsin Council on Forestry web site includes a link to the four tracks of Invasive Species Best Management Practices: Forestry, Recreational Users, Urban Forestry and Transportation and Utility Corridors.  
**<http://council.wisconsinforestry.org/invasives/>**

### **WISCONSIN DNR FOREST HEALTH WEB SITE**

The Wisconsin DNR forest health protection program web pages provide biology and management information on a wide range of forest health issues, regional forest insect and disease newsletters and contact information for Wisconsin DNR regional forest health specialists.  
**<http://dnr.wi.gov/forestry/Fh/>**

### **WISCONSIN DNR INVASIVE SPECIES**

The Wisconsin DNR Invasive Species web page provides links to invasive species information including a photo gallery, complete plant and animal invasive species lists, and information on managing invasive species populations.  
**<http://dnr.wi.gov/invasives>**

### **WISCONSIN'S EMERALD ASH BORER INFORMATION SOURCE**

The Wisconsin state emerald ash borer web site provides information on the status, biology and management of EAB as well as information on quarantine regulations.  
**<http://emeraldashborer.wi.gov>**