



Traditional Ecological Knowledge will also be taken into consideration. These assessments will be done with guidance from the US Fish and Wildlife Service and the DNR Bureau of Natural Heritage Conservation. There is no one-size-fits-all strategy for managing an infestation of EAB. The Wisconsin response plan may be viewed at: [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov).

### **Symptoms and Signs**

EAB-infested trees usually have multiple symptoms and signs of infestation if they have been infested for several years (Figs. 3-8). Be aware that similar signs and symptoms can be due to other causes.



Fig. 3. Thinning crown.



Fig. 4. Epicormic sprouts at the base of an infested ash tree.



Fig. 5. D-shaped exit hole created by an emerging adult beetle.



Fig. 6. S-shaped larval galleries.

Symptoms and signs of EAB infestation include thin foliage and/or dieback in the upper crown, epicormic sprouts on the stem or at the base, 1/8" D-shaped exit holes, S-shaped larval galleries under the bark, and heavy woodpecker activity.

EAB larvae are up to 1.5" long and have distinctive bell-shaped segments (Fig. 8). Collecting a suspected EAB specimen (larvae or adult) is very important for proper identification. Freezing the insect or preserving it in rubbing alcohol will maintain the specimen until an expert can examine it.

### **Reporting Suspects**

Monitor for symptoms of EAB infestation and report suspect trees and insects to the Wisconsin EAB hotline (1-800-462-2803), or email reports to: [DATCPEmeraldAshBorer@wisconsin.gov](mailto:DATCPEmeraldAshBorer@wisconsin.gov).

### **Risk of Introduction**

It is very likely that there will be additional detections of EAB in Wisconsin due to accidental transport of the insect in firewood, nursery stock and unprocessed logs. Campgrounds and urban areas are currently thought to be at highest risk of EAB introduction. Landowners should consider the likelihood of introduction in the local area when considering management options. Natural spread of EAB from an infested site is currently thought to be about 1/2 mile per year.

### **Future Impacts**

EAB will be more than 99% fatal to true ash species (Fig. 9) that are not treated with insecticide, regardless of a stand's ash density, size or species diversity. Scientific studies have found little natural resistance



Fig. 7. Woodpeckers pick away outer bark to eat EAB larvae beneath the bark.



Fig. 8. EAB larva beneath the bark of an infested tree.

to EAB in the native ash population, but long-infested states report that some ash trees remain alive. Insecticide treatments can stop or reverse tree decline in moderately-infested yard trees, but are not practical for treatment of ash in forests.

Long-term studies are underway to determine the effects of EAB on the ash forest and how the pest's population will change over time. It is hoped that future research will reveal new management options. At present, maintaining an ash component in forest stands will help to maintain species diversity and other benefits that ash provides.

Landowners should carefully evaluate long-term management options and determine which silvicultural practices are suitable for their stands. Preparing a stand for EAB impacts may allow the stand to remain adequately stocked with non-ash species and able to meet management objectives if all of the ash dies or is harvested.

**Removing all ash prior to EAB establishment in the local area is not recommended.**

EAB detection in the local area may lead to increased harvesting of ash and thus affect ash timber prices. Be aware that EAB impacts may affect lands enrolled in Managed Forest Law (MFL) and Conservation Reserve Program (CRP).

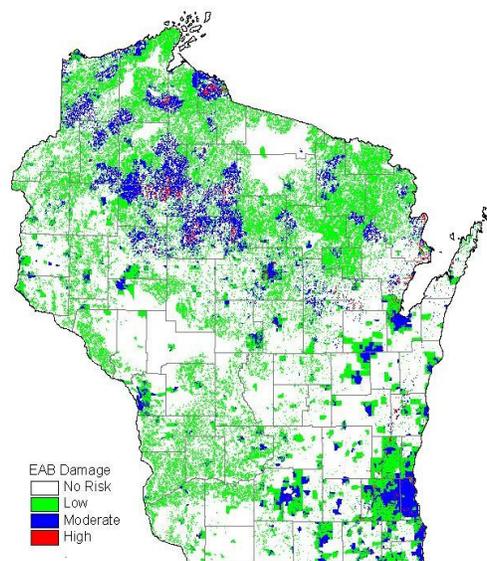


Fig. 9. Potential extent of ash mortality from EAB.

**It is important that landowners evaluate the potential impacts of EAB and consult with a forester to determine whether it is appropriate to adjust their management plan. The decision to alter a management plan will depend on several factors, including quarantines, distance from known EAB infestations, stand composition and age, management goals, and markets for the wood. In all cases, sustainable forest management practices should be followed.**

**The Ash Resource in Wisconsin**

There are over 700 million ash trees > 1” in diameter in Wisconsin’s forests, comprising approximately 7% of all forest trees greater than 1” in diameter (Figs. 10 and 11). Ash is also a common street and yard tree. Approximately 20% of urban street trees and 12% of all urban trees are ash.

White ash (*Fraxinus americana*) is rarely found growing in pure stands but is present throughout the state, occasionally as the dominant component in a forest. White ash grows on a variety of sites but is most frequently found on fertile, well-drained soils.

Green ash (*F. pennsylvanica*) is found throughout the state, but is most common in southern

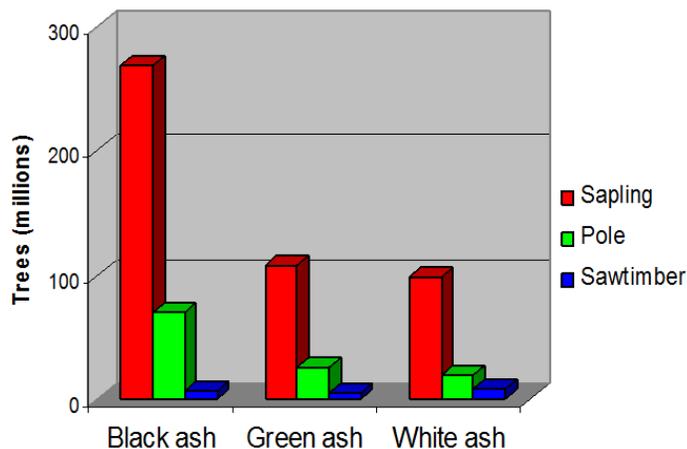


Fig. 10. Number of Wisconsin ash trees greater than one inch in diameter. Data are from USDA Forest Service Forest Inventory and Analysis plot network, 2006.

Wisconsin. It may form pure stands or grow in association with black ash, red maple, silver maple, swamp white oak, and elm. It grows as an associate in upland hardwood stands, but is most common in and around stream banks, floodplains and swamps.

Black ash (*F. nigra*) is distributed over the entire state but is most frequently found in northern Wisconsin. It is most common in swamps, but is also found in other wet forest types.

Blue ash (*F. quadrangulata*) is a threatened species that is currently found only at a few sites in Waukesha County. The species is at the edge of its range in Wisconsin, but is common in states farther south. The species is not of commercial importance in Wisconsin.

Mountain ash (*Sorbus americana* and *S. decora*) is not susceptible to EAB infestation.

**Ash Management in Forests**

Landowners should contact a professional forester for assistance with the management of their forests and ash trees. Landowners should carefully evaluate long-term management options and determine which silvicultural practices are suitable for their stands. Research may reveal new management options, and maintaining an ash component will help to maintain species diversity and other benefits that ash provides. Removing all ash prior to EAB establishment in the local area is not recommended.

**Management of Artificial Regeneration**



In quarantined counties, planting ash is not recommended. Outside of a quarantined county, plant ash only for special reasons (for example, to force other species to grow tall and straight) and limit ash to 10% or less of a new planting. It is unknown where EAB will become established in Wisconsin or how quickly it will spread, but there is a high risk that ash in a new planting will be killed before maturity.

**Management of Natural Regeneration**



In quarantined counties, review the ‘Silvicultural Guidelines for Quarantined Counties’ section. If outside a quarantined county, continue current management practices in seedling and sapling stands and sites that are naturally regenerating.

If the ash component represents > 10% of all regeneration, then consider reducing the ash component with release operations, favoring non-ash species. Retain the most vigorous ash stems. Active treatment of ash regeneration through cutting or herbicide may be needed. Supplemental planting of non-ash species is another option to increase the non-ash component. Where ash regeneration is predominant (> 50%), and if feasible, implement practices that discourage young ash and encourage regeneration of non-ash species through natural or artificial techniques.

Percent of species volume by ash basal area category

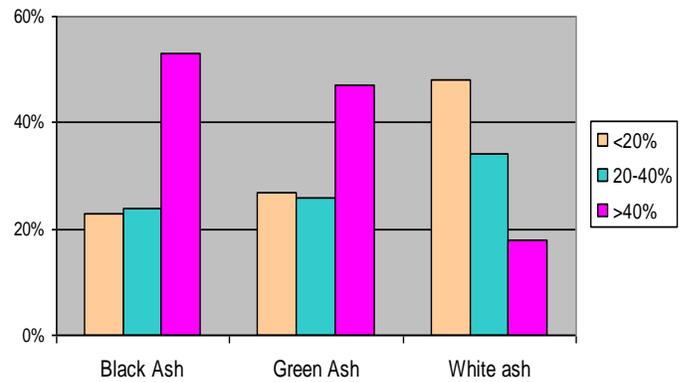


Fig. 11. Percentage of Wisconsin growing stock volume by ash dominance category. For example, a majority of black ash volume occurs in stands where black ash is more than 40% of the basal area. Data from USDA Forest Service Inventory and Analysis plot data, 2006.

### **Management in Established Stands**

**In quarantined counties, review the ‘Silvicultural Guidelines for Quarantined Counties’ section. For stands located outside a quarantined county but within 15 miles of a known infestation, consider using the recommendations for quarantined counties.**

Options for preparing forest lands will depend in part on the frequency of ash in the stand. As the proportion of ash rises, fewer management options will be available. These management guidelines have been developed based on three ash basal area levels: 1) ash < 20%, 2) ash 20-40%, and 3) ash > 40%.

### **Management in Established Stands Where Ash is a Minor Component (< 20%)**



If the stand is within a quarantined county, review the ‘Silvicultural Guidelines for Quarantined Counties’ section. If outside a quarantined county, continue normal long-term management activities with incorporation of the following guidelines.

In most cases where ash is a minor component, management goals will still be met even if EAB becomes established and all of the ash die or are harvested.

Follow the standard order of removal guidelines when selecting trees to remove or retain while keeping the stand adequately stocked. Ash is not yet considered high risk. Ash may be considered a less desirable species in the order of removal. Removing low vigor, stressed ash may slow the buildup of EAB and delay tree mortality. Keep ash that are of good form and vigor and encourage species diversity.

### **Management in Established Stands Where Ash is a Medium Component (20 - 40%)**



If the stand is within a quarantined county, review the ‘Silvicultural Guidelines for Quarantined Counties’ section. If outside a quarantined county, continue normal long-term management activities with incorporation of the following guidelines.

Reduce the proportion of ash during regularly-scheduled entries, aiming for a species composition (typically less than 20% ash) that would leave the stand adequately stocked and able to meet landowner goals if all of the remaining ash were harvested or killed as a result of an EAB infestation. Some stands may need multiple entries to reduce the ash component to an appropriate level.

Follow the standard order of removal guidelines when selecting trees to remove or retain while keeping the stand adequately stocked. Ash is not yet considered high risk. No more than 20% of the crop trees should be ash. Ash should be considered a less desirable species in the order of removal. Removing low vigor, stressed ash may slow the buildup of EAB and delay tree mortality. Keep ash that are of good form and vigor and encourage species diversity.

In some stands, the non-ash component may be primarily non-merchantable species or low-quality trees of commercial species. In this case, land managers should manage the stand using the recommendations where ash is a major component (>40%).

### **Management in Established Stands Where Ash is a Major Component (> 40%)**



If the stand is within a quarantined county, review the ‘Silvicultural Guidelines for Quarantined Counties’ section. If outside a quarantined county, continue normal long-term management activities with incorporation of the following guidelines.

Stands with a large proportion of ash (such as bottomlands, swamps or plantations) will be heavily impacted by EAB unless the ash component is drastically reduced. When planning management activities

consider two alternatives:

- 1) Reduce the proportion of ash during regularly-scheduled entries. Follow the standard order of removal guidelines when selecting trees to remove or retain, with these exceptions:
  - No more than 20% of the crop trees should be ash.
  - Ash is not yet considered high risk.
  - Ash should be considered a less desirable species in the order of removal. Removing low vigor, stressed ash may slow the buildup of EAB and delay tree mortality. Keep the stand adequately stocked.
  - **Because ash is a major component, multiple stand entries will be needed to bring the ash component down to a suitable level (ideally < 20% of stand basal area).**
- 2) Convert to other species through natural or artificial means, regardless of rotation age. Active treatment of ash regeneration through cutting or herbicide application may be necessary.

In many ash-dominated lowland stands, management of EAB will be difficult because silvicultural options will be limited and stand conversion may be impractical. EAB-caused mortality or excessive harvesting may lead to understocking, conversion to undesirable tree species or non-forest cover, elevated water tables or an increase in exotic plants such as reed canary grass. Attempt to keep the stand adequately stocked and favor species such as red and silver maple, swamp white oak and swamp conifers during release and thinning treatments. Active treatment of ash regeneration through cutting or herbicide application may be necessary. Consider establishing non-ash regeneration through natural or artificial means.

In many cases it will not be practical to reduce the proportion of ash because of harvesting impacts or lack of sufficient non-ash stems. EAB would still heavily impact the stand even if gradual species conversion was attempted, leaving it understocked and unable to meet landowner objectives. If a stand is in this situation, landowners may decide to:

- Allow EAB mortality to run its course.
- Alter management to non-timber objectives.
- Wait until rotation age, then convert to different species (if possible) prior to EAB establishing in the area. Shortening the rotation age may be appropriate.
- Wait until EAB establishes in the area, then pre-salvage harvest the stand and convert to different species (if possible). Be aware of quarantine restrictions.
- Wait until EAB impacts the stand, then salvage harvest the stand and convert to different species (if possible). Be aware of quarantine restrictions.

### **Silvicultural Guidelines for Quarantined Counties:**

**Quarantined Counties:** It takes 2 to 3 years for a tree to show symptoms of EAB infestation, making early detection very difficult. In addition, delimitation surveys are imperfect and resources for early detection work are limited. EAB infestations often turn out to be more widespread than is initially determined. Given these limitations, EAB quarantined counties are the best available indicator of where EAB is known to be present. **Salvage and pre-salvage harvests are recommended within an EAB quarantined county. Ash trees should be considered high risk for EAB mortality within the next harvest cycle.** Visit [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov) for current maps of EAB quarantine counties.

**Additional Considerations:** On average, adult EAB beetles spread about ½ mile per year. It is expected

that within a 15 year harvest cycle, EAB will spread naturally to an area 5 to 15 miles from a known infestation. Therefore, managers should consider implementing the following guidelines for all stands within 15 miles of a known infestation, even if currently located outside of a quarantined county. When determining if ash trees in very large quarantined counties should be identified as high risk, managers should consider the distance from known infestations. If an EAB infestation appears to be isolated to one end of a large county, it may be reasonable to delay the high risk designation for vigorous stands well outside of 15 miles. Even in this situation, consider accelerating harvest schedules to reduce ash levels.

*Recommendations within Quarantined Counties (and other high risk areas):*

Conduct a pre-salvage or salvage harvest of most or all ash. Consider retaining a few scattered ash trees for ecological purposes. Manage the residual stand or regenerate the stand based on the following guidelines:

- If pre-salvage or salvage harvest of ash will not result in a degraded stand (i.e., more than 40 crop trees per acre remain or the residual stocking of non-ash trees will be above C-line, approximately 45% relative density), manage according to cover type silvicultural guidelines.
- If pre-salvage or salvage harvest of ash will result in a degraded stand (i.e., less than 40 crop trees per acre or residual stocking will be less than the C-line, less than 45% relative density), regenerate the stand to non-ash species according to cover type silvicultural guidelines using natural or artificial methods.
- Lowland sites with a high percentage of ash may be very difficult to regenerate to non-ash trees due to prevalence of ash in understory, aggressive invasive species (e.g. reed canary grass) and possible rise in water table levels. Consider group or patch regeneration methods, planting non-ash species in about 1/3 of the stand. Once regeneration is established in these groups/patches, create regeneration groups/patches in another 1/3 of the stand. Intensive site preparation and release treatments may be required for successful establishment of regeneration.

### **Additional Resources**

Updated management guidelines and maps of EAB distribution will be available at [www.emeraldashborer.wi.gov](http://www.emeraldashborer.wi.gov) and <http://dnr.wi.gov/topic/Invasives/>. Emerald ash borer is a relatively new pest in North America, and management guidelines will change over time due to changing insect distribution, new research findings, introduction of biological controls, and availability of funding for management.