Akwesasne Mohawk Territory Emerald Ash Borer Community Response Plan

Final

Akwesasne Task Force on the Environment (ATFE), Saint. Regis Mohawk Tribe, USDA-APHIS PPQ

Contents

Introduction

The Mohawk Community of Akwesasne is a basket making community which has direct ties to natural resources utilized in making baskets. The materials primarily used in traditional Mohawk basketry include *Fraxinus nigra* (black ash), *Fraxinus americana* (white ash) and *Hierchloe odorata* (sweet grass). Basket makers expertly process materials gathered by traditional harvesters. The process of selection and harvesting follows traditional knowledge and practices where only select materials are harvested for making baskets. Further processing and final assembly into a basket is highly involved, labor intensive and relies on knowledge passed down through generations.

It is in consideration of the importance of ash resources for Mohawk basketry as well the ecological importance of the genera that this response plan was developed. Through this plan the community may better be able to respond, adapt and one day recover from the blight of the *Agrilus planipennis* (Emerald Ash Borer, EAB) that has fallen upon the ash resources of the country and the community.

Background

Traditional Mohawk basket making is directly tied to the viability of the black ash resource. Traditional basket making historically was very important to the Mohawks, providing income as well as connecting a complex network of crafts people who harvested trees, made splints, made tools and made baskets. As an income source basket making provided the means for many Mohawks to buy food and necessities for their families. Preserving, enhancing and regeneration of sustainable sources of black ash are critical to the perpetuating of basket making for culture and the economy that surrounds it.

The Emerald Ash Borer (EAB) is an invasive wood boring beetle from Asia that threatens North America's ash resources. It was introduced into the Detroit area by at least the early 1990's and has continued its spread. The EAB has impacted the landscape by killing millions of ash trees in almost a dozen states where ash is a significant component of timberland and urban forest land. Despite the best efforts by state, federal and local resource managers to manage EAB through outreach, education, awareness, regulation and physical interventions, it now seems that EAB will ultimately command a presence in the environment with a lasting legacy of almost total extirpation of the *Fraxinus* genera. Unlike other *Agrilus* species that are attracted to and attack mainly stressed trees, EAB is able to attack and kill presumably healthy trees in both natural and urban settings. Today, EAB infestations have been detected in 25 states; Colorado, Connecticut, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Michigan,

Minnesota, Missouri, New Hampshire, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. EAB appears well suited for climatic conditions in North America and destroys entire stands of ash trees. EAB will continue to disperse along continuous corridors of ash now present in natural and urban environments due to the widespread use of ash as a landscape tree.

The costs associated with the loss of ash are thought to be in the billions of dollars just from treatment, removal and replacement alone. It is challenging to pinpoint economic losses. Ecological costs are now being examined and have tremendous potential to severely impact water quality and wetlands. No one has ever assessed the cultural loss that basket making Indian Tribes will experience as a result of EAB.

EAB will not be eradicated, it has reached pandemic level and low density populations will continue to exist throughout the landscape.

The arrival of EAB will ultimately affect the basket making community. How this community chooses to respond to EAB will decide the future of basket making as many have known it for generations to come.

It is the hope that the community's response will continue to be one of adaptation as more is learned about EAB and ash preservation and conservation.

Reference: Herms, Daniel A., McCullough, Deborah G. Emerald Ash Borer Invasion of North America: History, Biology, Ecology, Impacts and Management. Annu. Rev. Entomol. 2014. 59:13-30.

Vision

By way of discussion with basket makers, log harvesters and pounders about Mohawk basketry, perpetuation of basket making, and with the knowledge that EAB is a threat the basket making community, developed these points that capture the vision of the community:

- To have plentiful trees (black ash) for basket makers
- Having teachers to teach basket making to future basket makers
- Having youth involved with basketry
- Having trees that are disease free
- Having trained people [basketry]
- Being able see grandchildren making baskets
- Having a plentiful supply of basket making materials (black ash, white ash, sweet grass, natural dyes)

- The trees are here [in the community] (Having them available and accessible for basket makers)
- Have environment (local environmental and natural resource managers) tells how to protect trees
- To educate the outside about black ash (to call attention to the importance of black ash so that they may support efforts to protect the resource)

Purpose

The Akwesasne Mohawk Territory Emerald Ash Borer Community Response Plan has been developed so as to provide the community with a clear understanding of the EAB risks, potential consequences to its ash resources and the tools to be able to respond to and to adapt to its presence.

The Plan outlines critical response concerns associated with a response to EAB, available resources and identifies key players who may be called upon in the event of an EAB detection in the community.

Scope

The applicability of this plan is the geographic area of the Akwesasne Mohawk Community. The Plan further serves as a tool for the community of Akwesasne, leadership, and forest managers to deal with EAB risk and infestation. As a product for the community, the ultimate product to be delivered is a dynamic, robust and flexible tool that can be utilized to address impacts of EAB, both potential and actual.

Goals

The goals for the community with regard to Mohawk Basketry and forest health include:

- The community has the goal to perpetuate basket making skills
- The community has the goal to continue to have basket making resources available to them
- The community has the goal of preserving and sharing knowledge about basket making
- The community has the goal of using multiple resources to manage the threat of EAB
- The community has the goal of providing awareness and education on the subjects of black ash and EAB
- The community has the goal of utilizing traditional knowledge and practices in the responding to EAB

These goals were derived through basket maker and black ash log harvester discussion at the Akwesasne Cultural Center and Museum. With these in mind, the response plan will develop strategies that will allow the community to achieve these goals.

Objectives

To reach the community goals several steps are necessary to achieve them.

What must the community do in order to reach its goals?

1. Continue to teach basket skills making to Mohawk youth.
2. Document basket making knowledge and skills of the Mohawk.
3. Create a local source of black ash basket making materials, e.g. black ash tree plantations, (consider alternative materials).
4. Identify existing local sources of black ash materials.
5. Teach the surrounding community about black ash and EAB issues.
6. Engage the larger community (shippers/transporters/government agencies [US Customs]) on the issue of shared responsibility of resource impacts/loss.
7. Assess the health risk effects of pesticides and bio-controls of EAB.

WHY is this important for the community?

1. Because basket making is an important aspect of the Akwesasne Mohawk way of life, traditions and practices. It is the identity of the people. It connects generations and is integrated into everyday life. It acts as a medicine for the people, promoting healthy minds and peace.
2. In order to maintain the practices of basket making, basket design, skills and practices.
3. To make materials more accessible to basket makers in the future.
4. To ensure that materials diverted to basket making and not lost for other uses such as firewood.
5. To promote a greater understanding of the importance of black ash its relationship to basket making and the negative impacts of EAB.
6. To identify the resources that will be necessary to achieve the goals of the Akwesasne basket making community.
7. To ensure that the health of the people is protected while controlling the EAB.

WHO is going to do what? Who else need to be involved?

1. The Akwesasne Museum and Cultural Center is the lead; basket makers and, elders.
2. The Akwesasne Museum and Cultural Center is the lead, Tribal Historians, basket makers, log harvesters\pounders.
3. Environmental/Natural Resource Agencies/Organizations are the lead.
    a. SRMT Environment Division, Forestry Resources
    b. MCA Environmental Services
    c. Akwesasne Task Force on the Environment (ATFE)
    d. Individual landowners and Forest Owners
4. Log harvesters/pounders are the lead, Amish, landowners.
5. Environmental/Natural Resource Agencies/Organizations are the lead: basket makers, log .harvesters/pounders, Akwesasne Museum and Cultural Center, Public Information Offices.
6. Tribal Governments are the lead for protecting the resources: Basket makers, Shippers/transporters, regulatory agencies.
7. Environmental/Natural Resource Agencies/Organizations are the lead.

WHEN do I want this to be completed?

Some measures require immediate action, others are continuation of actions already in place and other actions must yet be initiated.

1. Continuing Actions -
    a. Teaching basket making skills
    b. Teaching log harvesting skills
    c. Raising awareness about the cultural importance of Mohawk basketry to outside organizations and governmental agencies that hold trust responsibilities for Native Americans.
    d. Network with other Native American tribes and basketry organizations to generate support and ideas to deal with EAB
    e. Educate the community about EAB and other invasive insect pests
    f. Monitor for EAB and other invasive insect pests
2. Immediate Actions -
    a. Prevention of the introduction of infested materials
    b. Adapt forest management plans to emerging pest threats
    c. Engage coordinating agencies in a joint response exercise
3. Immediately within the next year
    a. Management of forestry resources to reduce EAB impacts

b. Management of urban and community forest components to reduce EAB impacts

4. Longer-term
    a. Identification of alternative locations of low risk black ash material
    b. Identification and evaluation of alternative basket making materials

HOW can these be accomplished?

1. Identify resources that support basket making training.
2. Videograph/interview, catalog and archive basket makers and log harvesters/pounders
3. Establish black ash plantations
    a. Manage them for optimum growth, insect pest management and harvest, processing and distribution.
    b. Evaluate alternative materials.
4. Reach out to surrounding community and establish a communications channel and point of contact.
5. Through publication and distribution of outreach and educational materials.
    a. Local events
    b. Local media
6. Establish contact/invitee list and organize a kick-off meeting.
7. Engage appropriate agencies to research and communicate potential health risks associated with EAB controls (chemical and biological).
8. Identify and work with plant materials experts
9. Identify and work with other Native American basketry organizations

"There's a difference between interest and commitment. When you're interested in doing something, you do it only when circumstance permit. When you're committed to something, you accept no excuses, only results." – Unknown

Outcomes

As measures of success toward the community goals, the most favorable outcome is that of no EAB infestation. However, given the history or the spread or EAB this seems unrealistic and EAB infestation is likely inevitable. Therefore, the most realistic outcome includes results that serve to:

- Maintain the rich cultural heritage and self expression and identify through Mohawk Basketry
- Limited impacts from EAB infestation by having a diverse and healthy forest and urban and community forest component

- A delay in the overall loss of ash resources by identifying harvest resources outside of an immediate EAB threat area
- Increased level of support and coordination with multiple agencies that have a trust commitment to assist the community with maintaining its ash resources
- A well established and nurtured network of Native American basket making communities
- A long-term prospect for use of alternative basket making materrials

Outputs

This plan is meant to be a living document and as such will evolve and adapt as the threat of EAB changes from a risk to a reality. There will also be changes in personnel and contacts within various agencies, technologies will change and evolve as will policies and regulations which affect provisions of this plan. As a matter of practicality and efficacy a primary output should include revisions to the plan or at least an annual review of the plan to incorporate the latest knowledge and wisdom of the time.

Other foreseeable outputs associated with the plan include:

- Numbers of basket making classes and number of students instructed, numbers of instructors involved
- EAB and Invasive Pest monitoring results

Roles and Responsibility

Organization/Contact Information	**Role -**	**Responsibility - actions, decisions, initiate actions, consultative**
Saint Regis Mohawk Tribe Tribal Council	Governmental Leadership - Tribal Policy	Protect the interests of the Tribal Community
Saint Regis Mohawk Tribe Environment Division	Natural Resource Management	Natural resource planning and management
USDA - APHIS PPQ	Consultative approach to Protecting and Promoting Natural Resources, Regulatory	Provide leadership in pest monitoring, support with rapid response and possible biocontrol, aid in navigation of import/ export regulations of forest products
ATFE	Natural resource protection advocacy and activism	Technical Specialists

Akwesasne Cultural Center and Museum	Cultural preservation	Cultural Advisor
Mohawk Council of Akwesasne	Governmental leadership and policy	Governmental responsibility for areas within Canadian jurisdictional areas.
BIA	Tribal forest protection support	Assist with response actions
USFS	Forest entomology support	Assist with response strategies
Basket Makers and Harvesters	Traditional knowledge	Cultural and technical specialists
The Ranger School	Academic leadership	Research and study
University of Maine	Academic leadership	Research and study
Maine Indian Basket Alliance	Traditional basketry preservation	Technical and cultural specialist

Responses

Monitoring and Surveillance

The single most important action that the community can be involved with is that of EAB monitoring and surveillance. Tribal and community resources are actively involved and will continue to be involved with EAB monitoring and surveillance. Monitoring of EAB infestations and keeping current about new infestations and quarantines is important to preparing for EAB impacts and response actions. As part of this effort community members are regularly provided with outreach, education and information through local media and at community events such as the Akwesasne Task Force on the Environment Seed and Tree Day. EAB information is distributed at this annual event to inform the community about the risks and how to prevent further movement of EAB.

Trapping - The Tribe works in conjunction with USDA-APHIS- PPQ in setting purple prism traps out during the summer months when EAB is biologically and reproductively active. There are 18 traps set out around the reservation. The traps are designed to attract EAB if they are present (they don't draw them in) using natural lures (pheromones) and a sticky substance to trap them onto the trap. The traps are inspected weekly. This program has operated for 5 years and to date no EAB has been detected.

Sentinel Tree - Selected ash trees are girdled causing them to give of a signal that EAB finds attractive. If EAB is present, they will deposit their eggs on the ash tree and the larvae will grow in the bark layers creating galleries. The tree is cut down in the fall and inspected for galleries

and larvae will be present. This project has been operational since 2012(?) and no EAB larvae have been detected to date.

Ash Importation

The community relies upon a supply of black ash from Native or aboriginal communities in Canada where EAB is not found at this time. While Mohawks have enjoyed the practice of harvesting black ash from these communities and transporting them back to Akwesasne, the USDA-APHIS-PPQ and US CBP in a joint effort to ensure that EAB and other insects weren't also be transported introduced processes for ash log importation. Ash concerns over accidental importation of insect pests increased and as any travel through a US port of entry became more challenging following the 911 terrorist attacks, ash log importation became more difficult. Compounding the situation was the introduction of newer CBP officers that were unfamiliar with the practices and customs of the Akwesasne Mohawks and the need to comply with regulatory requirements that CBP officers are tasked with.

Initially, the process was an informal Memorandum of Understanding (MOU) and Form Letter from 2009, written by U.S. Customs and Border Protection. The MOU consisted of a statement of origin letter from the log harvester. While this worked well for some time, U.S. Customs and Border Protection was questioning USDA about the age of the MOU and sought consultation from USDA. At that point, USDA-APHIS-PPQ determined that their mission and regulatory concerns weren't being met. USDA determined that according to the Code of Federal Regulation (CFR), a formal Import Permit was needed.

The Saint Regis Mohawk Tribe undertook discussions with the USDA-APHIS over several months including a waiver request. The waiver request was not consistent with the Code of Federal Regulations, which are not easy to change and so the waiver was denied. The State Plant Health Director of New York, Diana Hoffman, sought consultation from the Associate Executive Administrator in Washington, D.C. to see if this project was applicable for a new Regulatory Flexibility Project. It was approved and ultimately, a less restrictive general permit to import was filed and issued. The general permit considers risk and safeguarding measures, and it provides a simple process to follow while meeting the community's needs. The permit is easy to read and easy to use. During the discussions leading up to the permit process the Tribe secured assurances from USDA and CBP that the permit would be administered with sensitivity toward the unique needs of the Mohawk community of basket makers and black ash log harvesters.

The USDA-APHIS-PPQ has agreed to facilitate sensitivity training and awareness between the Tribe and CBP with regard to the unique needs of the Akwesasne Mohawk basket making and log harvester community.

General information about the permit:

- The permit holder is the Saint Regis Mohawk Tribe, community members are required to carry a copy of the permit with them when transporting black ash through the port(s) of entry. This requirement is optional. Community members not utilizing the permit may encounter delays at the port(s) of entry without a copy of the permit
- The permit applies to the ports of entry in Massena and Ogdensburg, NY
- The permit is valid for 3 years beginning 10/14/14
- The permit is specific to ash

Reference: Permit to Import Timber of Timber Products, Permit 2014-01 PPQNY, Appendix A.

Forest Management

Custodial Management Plan

The Tribe has developed a Custodial Forest Management Plan (FMP) that describes the Tribe management practices to ensure the health of the forests on the reservation for the benefit of the community members. Essentially, the plan allows for the prosecution of trespass, monitoring of insect and disease populations, emergency fire rehabilitation and free use harvest of minor forest products, including timber, by tribal members. The custodial plan doesn't allow activities such as prescribed fire or the commercial harvest of forest products. The FMP satisfies 25 CFR 163.11 and the legal requirements in P.L. 101-630 (53IAM 2.4) which states that "an appropriate forest management plan shall be prepared and revised as needed for all Indian forest lands."

The FMP is based on a forest inventory and inventory report recommendations and considers the diverse interests and priorities of individual landowners as well as the qualities of the wildlife, riparian areas, culturally significant plants, animals and invasive plant species and insect pests.

The USFS created and addendum for the FMP with regard to EAB concerns. The revision presents forest management options with the goal to reduce EAB risk in forest stands. The strategies are:

- *Forest stands with a minor component (<20%) of ash*—If potential economic damage is low, continue normal long-term management of the stands, because management goals can be met even if all of the ash die or are harvested as a result of EAB infestation. However, ash may be considered a less desirable species and

consideration may be given to thinning ash to shift stand to best residual (non-ash) trees. Openings may need to be monitored and/or treated for intended regeneration.

- *Forest stands with a medium component (20%-40%) of ash*— If potential economic damage is moderate, normal long-term management of the stands may be continued, but reduce the proportion of ash during scheduled stand entries. The target for ash in these stands would be <20% of the species composition, while still leaving well-stocked stands. This target allows for meeting long-term management objectives in the event that all of the remaining ash are killed or harvested due to EAB infestation. Some stands may need multiple entries to achieve the goal of reducing the ash component to <20%. Ash with low vigor and poor form should be removed first.
- *Forest stands with a major component (>40%) of ash*— If potential economic damage is high, long-term management activities may be continued while considering harvesting high-value ash and low-quality residual non-ash trees to favor desirable species and quality trees. Development of a regeneration plan may be critical if natural regeneration is limited. In general, either one of two timing options may be considered:
    1. Reduce the proportion of ash during scheduled stand entries, following the standard order of removal guidelines when selecting trees to retain and remove, except that no more than 20% of the crop trees should be ash. Multiple stand entries will be needed to reduce the ash component to the target level. This timing option may be preferred if known EAB infestations are more than 15 miles away (see below).
    2. Convert the stands to other species, regardless of the rotation age. Attempt to keep the stands fully stocked while favoring non-ash species and removing all ash trees and ash regeneration. Other options may need to be considered if the above actions are not practical because of harvesting impacts or because management objectives cannot be met. This timing option may be preferred if known EAB infestations are less than 10 miles away (see below).

While the potential economic impacts of EAB infestation are dependent on the ash inventory of a stand, the proximity to known EAB infestations play an even greater role in the risk of a stand becoming infested. Forest stands more than 15 miles from known EAB infestations may be considered low risk for EAB invasion over the next 5 years, whereas stands within 10 miles of known EAB infestations are at a higher risk of EAB invasion in the next 5 years. That estimate, however, is highly dependent on human-aided movement of EAB-infested material. For instance, forest stands located within a quarantined area may be at a higher risk of infestation because infested ash material may move freely within the quarantined area, increasing the likelihood of rapid spread of EAB in the area. As a result, the following recommendations should be considered regarding proximity to known EAB infestations:

- *Forest stands located more than 15 miles from a known EAB infestation*—These stands are generally low risk for EAB invasion in the next 5 years. Manage the stands with ash according to the general silvicultural guidelines outlined above.
- *Forest stands located less than 10 miles from a known EAB infestation*— These stands are at a higher risk for EAB invasion in the next 5 years. Salvage and pre-salvage harvest of all or most of the ash is recommended because these trees are at high risk of being killed by EAB. Manage the residual stand according to silvicultural

guidelines for the cover type if the residual stand still meets minimum stocking standards (C-line). If the residual stand does not meet minimum stocking standards, regenerate the stand to non-ash species according to silvicultural guidelines for the appropriate cover type.

Urban and Community Forest

The Tribe's Urban and Community Forest (UCF) program is at its infancy. Current efforts are aimed at inventorying and to assess the UCF component of the reservation. The goals of the UCF program are to:

- Manage UCF for the health and well being of the community by managing hazard trees
- Enhance the health of UCF by planning and management to increase the health and vigor of trees, making them less susceptible to insect pests and disease
- Provide the community with opportunities for energy conservation, a greater sense of well being, increased air and water quality and increased community aesthetics through UCF

Through UCF the Tribe intends to develop an inventory, an inventory report, an inventory map of UCF and a community wide UCF management plan.

The UCF with regard to EAB will address:

- Hazard trees created by EAB infestations
- Costs for tree removal associated with EAB infestations
- Availability of resources to manage hazard tree removal
- Mitigation efforts to reduce EAB impacts to UCF
- Street and landscape tree replacement of ash trees lost to EAB
- Public outreach and education regarding UCF and EAB related issues such as pesticide usage and tree removal and biological controls
- Tree utilization and waste disposal
- Treatment options and timings
- EAB survey and detection

Pesticides

Great care and consideration must be given regarding the use of pesticides for managing EAB to ensure their safe use, efficacy, potential risks and benefits. The selection and use of pesticides is best left to qualified and credentialed applicators, forest managers and pest specialists. The general precaution is to advise individuals to not attempt self application and to verify credentialing of applicators through Tribal compliance and environmental programs before permitting anyone to apply pesticides.

EAB cannot be eradicated but their populations may be suppressed. EAB populations changed and build slowly, later increase rapidly and then collapse but persist. Understanding EAB population dynamics is critical to management of EAB using insecticides.

Factors to consider in the usage of pesticides include:

- Treatment area (acreage)
- Timing of treatment
- Treatment site, urban or timber stand
- Active ingredients of the pesticide
- Cost
- Efficacy of pesticides
- Annual use limits
- Where the pesticide is applied, soil, trunk, foliage
- Water bodies in the treatment area

In general, pesticides will not be used in forest applications unless deemed appropriate for specific extenuating circumstances and following consultation and review between the community, BIA, USFWS and USEPA. Pesticide usage will be limited.

Types and Use

Systemic Soil Injections or Drenches

Currently, imidacloprid and dinotefuran are systemic insecticides applied as soil injection or drenches and are found under various brand names. They are typically mixed with water to a specific concentration and poured directly onto the soil around the bases of a tree trunk or injected using specialized applicators a few inches below the ground. The objective is to deliver the insecticide to the roots of the tree where they can be taken up and moved throughout the tree. Injection of pesticides reduces the chance for runoff. Both drenching and injection are highly effective because uptake is higher. With drenches, leaf matter and interfere with uptake. The

amounts used are dependent on tree size. There are limits on the maximum amount that can be applied per acre during a given year. This amount is a regulatory limit and must be followed. Additional concerns are for bees and other pollinators in nearby flowering plants. If flowering plants can't be avoided then trunk injection is recommended.

Soil applied systemic insecticides are considered to have inconsistent results for control of EAB, ranging from excellent to poor results. These results may be due to varying application protocols and site conditions and other site factors such as tree diameter. It is thought that as tree size increases the efficacy decreases and therefore may be better suited to smaller trees.

Systemic Trunk Injections

There are several products on the market that contain azadirachtin, emamectin benzoate, and imidacloprid. They are typically used where soil application isn't practical on sites that are excessively wet, sandy compacted or otherwise restricted. Injection is accomplished by drilling into the bark and sapwood as the base of a tree followed by injection with specialized equipment that utilize high pressure. Frequent applications can damage the tree. Pesticides that are injected are absorbed more quickly as compared to soil treatments. Timing is important and must occur after leaf out when trees are active.

The effectiveness of injections seems favorable, yielding excellent results but is dependent upon the specific product being used. Applications may be effective for 2-3 years for some products.

Systemic Trunk Sprays

Trunk spraying is non-invasive and involves spraying insecticide on the lower 5 to 6 feet of the tree trunk with a common garden sprayer and low pressure. This is a quick and easy method, doesn't damage the tree and doesn't enter the soil if applied properly.

The effectiveness of trunk sprays is considered to be about the same as for soil applications but better than no treatment at all.

Protective Cover Sprays

This particular method is used to kill adult EAB beetles and newly hatched larvae, and therefore has to be timed when most adults have emerged. Products typically used are formulations of permethrin, bifenthrin, cyfluthrin and carbaryl.

Insecticides that have been identified for use in the control of EAB were tested and found to be effective in the control of EAB as it is toxic to the insect.

Cover sprays are considered effective only for adults beetles but insecticide drift and impact on other organisms being the primary concern.

Regulatory Framework

Insecticides are an option but carry with their use are great deal of care and responsibility. Most importantly labels should be read and directions followed. Some products are sold to consumers and can be applied but if misapplied can be just as harmful as regulated pesticides. Other products are labeled for professional use only and should absolutely not be applied by anyone without the proper training and certification.

All applicators have the legal responsibility to read, understand and follow all label directions for the specific insecticide being used.

Tribal

The St. Regis Mohawk Tribe currently does not have an applicator certification program and doesn't issue certifications or licenses. Currently, applicators using RUPs must conform to Federal pesticide regulations including meeting all training requirements, submitting an application and being certified.

The St. Regis Mohawk Tribe, Compliance Office, requires all non-reservation vendors to register with their office prior to conducting business on the reservation and complying with all Tribal ordinances.

Federal

EPA regulates pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The USEPA identifies and regulates restricted use pesticides (RUPs) because of their potential harm to human health and to the environment. RUPs require special handling to reduce these potential impacts while managing insect pests.

Under current law an applicator state certifications are not valid on the St. Regis Mohawk Reservation and therefore applicators must be certified and possess a EPA certification card to apply RUPs on the reservation.

The USEPA is responsible for enforcement of pesticides laws on Indian reservations unless a Tribe has their own program. At present the St. Regis Mohawk Tribe doesn't have a pesticide plan.

State

The New York State Department of Environmental Conservation (NYSDEC) is the state agency that regulates pesticides and is responsible for compliance assistance, public outreach activities and enforcement of State pesticide laws.

Any applicator based in New York State must be certified and registered with the NYSDEC.

Guidance: Appendix XYZ, Herms DA, McCullough DG, Smitley DR, Clifford CS, Cranshaw W. 2014. Insecticide options for protecting ash trees from emerald ash borer. North Central IPM Center Bulletin. 2nd Edition. 16 pp.

Scams

In areas where EAB infestations have taken place unscrupulous operators of fly-by-night pest management services have exploited fears about EAB and bilked people out of money. Often times homeowners will be solicited by companies offering services that turn out to be expensive and ineffective and sometimes not even necessary.

Community members are cautioned to not agree to services offered by unsolicited companies. Additionally, they should check with the Tribal environmental department and compliance office to determine if a company is not only legitimate and reputable but also licensed and certified.

Reference: Wisconsin Department of Agriculture, Trade and Consumer Protection. Worried About EAB Scams? Knowledge and Professional Help Can Protect You. News Release, 8/15/12.

Bio-control

Biological control is a long-term management strategy accepted throughout the world for the sustained control of invasive insects. This approach is used for non-native species that 1) have been established for more than 5 years, 2) cannot be eradicated and 3) cause significant ecological or economic damage. Biological control involves research in the insect's country of origin to find, isolate, and identify its natural enemies, ranging from parasites to predators to pathogens. In the U.S., permits for release of highly host-specific natural enemies or "biocontrol agents" may be granted by USDA APHIS PPQ after completion of extensive research on the biology of both the host and its natural enemies in the U.S. and in the country of origin, risk benefit analyses, public comment, and state

concurrence.http://www.nrs.fs.fed.us/disturbance/invasive_species/eab/control_management/biological_control/) .

The use of biological control agents in North America is expected to suppress EAB densities below tolerance thresholds for native ash trees. Therefore, the community needs to recognize that biological controls aren't intended to eradicate EAB, they can be part an overall effort to manage EAB.

Spathius galinae

The Tribe received, reviewed and commented on the USDA document, Field Release of the Parasitoid *Spathius galinae* for the Biological Control of the Emerald Ash Borer (*Agrilus planipennis*) in the Continental United States, Environmental Assessment, Tsiothorko:wa/January 2014. The assessment presented a range of alternatives in view of the biological aspects of the wasp, it's preference for parasitizing EAB, being more robust than previously selected wasps and ability to suppress EAB populations. In September 2014, the Tribe issued a letter in support of use of *Spathius galinae* as a biological control.

The tiny stingless wasp, about the size of a typical mosquito, targets and attacks EAB larvae living under the bark of ash trees. Crawling along the bark ridges and furrows, *S. galinae* senses EAB larvae hidden under the bark. The wasp not only accurately locates its target, but also is able to determine relative size—showing preference for large EAB larvae. Once a suitable larva is detected, the female wasp uses its long egg-laying organ (ovipositor) like a hydraulic drill to bore down through the layers of bark and deposit between 5 and 15 eggs on its host. After the eggs hatch, the wasp offspring feed on the EAB larva, eventually killing it. A new generation of *S. galinae* emerges in about 35 days.

S. *galinae* was collected from the Russian Far East region and is not native to the United States. The wasp is a hardy parasitoid capable of surviving the severe Russian winters of the region in which it was first found. This characteristic, along with its long ovipositor, make S. *galinae* an optimal fit for release in the northern EAB-infested States. In addition, extensive studies indicate *S. galinae* targets only EAB, and does not attack or parasitize other native wood boring beetles, such as the bronze birch borer.

Before this potential new tool is used in the United States, the U.S. Department of Agriculture (USDA) will prepare and publish an environmental assessment (EA) identifying the risks and benefits of releasing *S. galinae.* The EA will be published in the Federal Register to allow the public to review and submit written comments prior to any release. Issuing permits for the release of *S. galinae* is part of USDA's responsibility in regulating biological control organisms.

If permitted, the release of *S. galinae* could occur as early as 2015 in EAB-infested states (http://www.fs.fed.us/blogs/new-weapon-fight-protect-americas-ash-trees-under-evaluation).

Alternative Basket Making Materials

While the community goal is to preserve the ash resources and that the hope is that ash will continue to be available of basket making, although it may become scarce and longer distances may have to be traveled to obtain it, the community may consider alternative materials for basket making to supplement or supplant black ash altogether. Ultimately, the need for alternative materials will be driven by the extent to which black ash becomes available or unavailable. The choices will likely be determined by a number of factors: availability, material qualities (compared to black ash), familiarity, cost. The presentation of alternative materials is limited and additional thought and consideration will likely yield a larger list then initially presented here.

Manchurian Ash has a potential to be used as a replacement for black ash and is EAB resistant or tolerant. The tree is similar in appearance to black ash in many respects. It has been grown in North America for many years as an ornamental tree. The wood has similar properties to black ash and can be pounded. The material has not been evaluated by any basket makers. It isn't known how the selection of seed/tree stock available in North America was selected. Most trees selected for landscape purposes tend to be selected for large crown and branching, characteristics opposite of what a basket maker is looking for. There may be other Manchurian ash from Asia that display characteristics in bolt, growth ring, and size that exist and may be suitable for basket making but not enough research has been done in this area to determine that.

Oak

The Cherokee utilize white oak for their basketry. Processes used in obtaining splints are similar in many ways but differ primarily in the way that splint material is prepared. White oak seems to be in plentiful supply in the North but it isn't known if anyone has attempted to use it in this area for basket making. Investigation into the use of oak needs to be done to determine if oak can be used in place of black ash.

> *Cherokee Basketry has endured from prehistoric times to the present day. The women do the basket making. The principal materials used by the Cherokee are cane, white oak, hickory bark and honeysuckle. Originally the only two materials used for dyes were black walnut and blood root. Butternut has been added for black, yellow root for yellow and broom sedge for orange.*
> (http://www.cherokee.org/AboutTheNation/Culture/CherokeeArts/CherokeeBaskets.aspx)

Because oak trees grew abundantly on mountain slopes, white oak became a popular material for making baskets. While oak baskets were made throughout the Appalachian mountains by Native Americans and European settlers alike. By the 1970s, however, Agnes Welch already noticed a decline in this resource.

"My husband cuts the oak saplings for me. But I do everything else. I prepare the materials and do the dyeing and the weaving...The right size of white oak is getting harder and harder to find. It's got to be from four to six inches thick. If they're any larger, the grain's too coarse and tough and won't peel into splints."

She explained the process further. After felling the saplings, her husband split them into three-foot sections and then into half-inch strips. "That's when my work begins," she said.
"After they are peeled, I take my knife and shave them down smooth. It's a tedious job. And then I dye them and soak them in water to keep them pliable so I can work them into the basket. They'll get stiff if you don't and you can't weave them at all."(http://www.wcu.edu/library/DigitalCollections/CherokeeTraditions/People/Baskets_AgnesWelch.html)

Split Cane

According to Wikipedia split cane is the material of choice by several Southeastern Tribes.

Chitimacha Basketry can be known as a truly handmade basket, because after the cane is gathered, it is split into long strips. The split cane is then peeled with the teeth, or when the basket maker becomes elderly and has no teeth, they grasp the end of the cane under the chin and peel it with the fingers.

The cane is dyed for designs (black from the black walnut, red from the dock plant, and yellow from a lime solution), the cane is then peeled a second time. After the second peeling the cane is then ready to be used in a basket. Cane with joints as far apart as possible is chosen purposely in order to give the surface of the basket a smooth finished appearance.(http://www.chitimachabasket.com/)

Phragmites

Phragmites australis (phragmites) is an invasive plant is native to North America found mainly in the south and southwest and also occurs in Europe. The European strain was found in North America in the early 1900's. It is a very aggressive plant and is become more abundant in the

community and can readily be found in ditches, follows waterline excavations and in wetlands. While we are having to deal with the impacts of its vigorous growth it is interesting to note that it is becoming scarce in England where restoration efforts are taking place (http://www.nycgovparks.org/parks/reeds-basket-willow-swamp-park/highlights/12267). Phragmites is used in Europe for making thatched roofs, mats and other weavings. Phragmites has been and continues to be used in basket making and is a potential candidate as a substitute because of its abundance.

Powhatan Indians (in the Chesapeake Region of Virginia) were using reed mats to build their homes, as mats for the floor, as well as for baskets when they met their first Europeans. Powhatan Indian Women: The People Captain John Smith Barely Saw Helen C. Rountree *Ethnohistory*, Vol. 45, No. 1 (Winter, 1998), pp. 1-29.

New techniques need to be learned in material gathering, preparation and weaving. More importantly acceptance by basket makers as a substitute needs to be determined.

Preservation

Preservation is the effort to keep or maintain and primarily is restricted to preservation of genetic resources. Significant efforts have been made to collect and store the genetic resources of all ash including black ash in advance of ash tree loss. The community has partnered with USDA, National Center for Genetic Resources Preservation, the National Seed Lab and the Mid Atlantic Seed Bank to collect and store ash seeds in long-term cold storage. These efforts will ensure the ability of the community to recover and restore ash resources once the EAB has been controlled.

Seed Resources

The Akwesasne Task Force on the Environment (ATFE) has been involved with long-term ash seed storage with the support of NCGRP. Seed storage will remain and important aspect of future restoration measures.

To the extent possible the ATFE and the Tribe will continue efforts to collect and preserve ash tree seeds utilizing existing storage resources as may be found at the NCGRP.

The processes for ash seed collections include:

1. Travel throughout areas associated with basket grade trees to identify ash trees with flowers
2. Collect GPS points for areas with ash trees that are flowering
3. Collect photographs of ash trees that are flowering

4. Record information about trees that are flowering
    a. Species identification
    b. Location description
    c. Date, time, weather conditions
5. Collect, handle, store and transport/ship ash seeds in accordance with established practices and standards, Methods for Collecting Ash (*Fraxinus spp.*) Seeds, Kathleen S. Knight, Robert P. Karrfalt, Mary E. Mason. (http://www.nsl.fs.fed.us/geneticconservation_ash.html)

Recovery

The future for ash and black ash basketry is difficult to predict with any degree of certainty. What is known is that EAB has dramatically impacted the Anishinabe basket makers of the Great Lakes. It has resulted decimation of an important cultural resource. These effects will likely be felt by the Akwesasne community as well as other Northeastern Native American basket making communities as EAB continues to spread. In addition to the forest and ecological impacts there will be cultural as well as economic impacts that will be borne by the community.

Knowing that these impacts will eventually arrive will make the community better prepared to manage them.

Long-term recovery from these impacts will have to address each component that is affected. Additionally, recovery need to be driven by the goals of the community in order to have any relevancy. Recovery must include strategies and tactics that result in the continuation of basket making, cultural expression, cultural identity and the connection between the natural world (black ash trees, trees, sweet grass) and the people.

Essential Element	**Risk**	**Impacts**	**Recovery - Strategies**
Forest Health	High	Loss of ash Biological gaps	Suppression of EAB Active invasive species management Replanting of ash
Ecology	Moderate	Negative impacts to wetlands Loss of diversity	Monitoring Plantings
Cultural Expression and Identity	High	Loss of connection to natural world Loss of traditional knowledge	Alternative materials Redirecting of creativity toward other act Plantations of black ash Travel to areas without EAB to obtain ash
Economic	Moderate	Financial loss to basket makers, harvesters, market place	Travel to areas without EAB to obtain ash Compensation for losses

		Changes in employment Impacts on local and regional services	Replacement of livelihood Plantations of black ash
Socio-Cultural	High	Interpersonal relationships Psychological impacts Changes in quality of life	This is an area deserved of further investigation. However, much can be learned from the experiences of the basket making communities in Michigan to help prepare communities in Native American communities that will be impacted.

Adaptation

As EAB spreads, its impacts will surely be felt in Akwesasne as they have been in communities where EAB is already present. For Akwesasne adaptation is a future concern. But, in native communities adaptation has and is already occurring. The adaptations are both positive and negative. Gaining and understanding of the experiences of these other native communities may be helpful for Akwesasne to consider. While the forestry, ecological and economic impacts have been estimated and evaluated it is doubtful that much effort has been put toward the socio-cultural impacts of EAB on native communities.

- Black ash trees remain harvestable for several years following EAB infestation but contain defects. The defects are in the first 2 to 3 layers of the tree and include larvae cavities, pock marks and discoloration. The material still retains its strength and workability. These layers have to be removed. A single tree has less material for basket making.
- Less desirable materials can be used for basket training classes, higher quality material is reserved for juried art and baskets to be sold
- Materials are not wasted
- Land owner issues. In some cases, private landowners have opened lands up for basket makers and harvesters. In other cases, where logs have been poached, landowners have closed their land off totally. This has given a bad name to the basket making community.
- The distance to obtain basket quality logs has increased significantly. Associated costs with travel has also increased, e.g., fuel, lodging, meals, hauling (hiring a truck).
- Some basket makers have given up altogether and stopped making baskets.
- Some basket makers have moved to using other materials for basket making.

- Costs for basket making materials (ash) have gone up excluding many basket makers from being able to make baskets because they don't have enough money to pay for materials
- With the loss of the resource and reduced availability and premium on trees there is less teaching, less sharing and many are hesitating to help others. Many are being very protective of their sources for materials.

Resources (Response)

Resource	Actions
Akwesasne Task Force on the Environment	Liaison for natural resource protect Community outreach and education
Saint Regis Mohawk Tribe	Increase monitoring and surveillance Disaster declarations Mobilize local governmental resources to assist individuals, groups, public and to eliminate or reduce hazard risk and vulnerability Make formal requests for assistance Remove and dispose of infested trees Save yard and community trees to the greatest extent possible Chemical treatment Seek financial resources for assistance
Akwesasne Cultural Center and Museum	Liaison with basket making and log harvesters in the community
Mohawk Nation Council of Chiefs	Keepers of Knowledge, providing guidance in traditional environmental knowledge.
Mohawk Council of Akwesasne	Mobilize resources to address EAB within jurisdiction.
USDA-APHIS	Institute quarantines, EAB identification and verification. Initiate bio-control actions
USEPA	Regulatory oversight in pesticides application and usage
NYSDEC	Liaison for protection of state resources in adjoining boundary areas
BIA	To protect timber on Indian lands from fire, disease or insects (16 USC § 594)
USFS	Implement Integrated Program Strategy for Reducing Adverse Impacts of Emerald Ash Borer Throughout the Northeastern Area

	Assist Tribal governments with preventing spread of EAB and adverse impacts Manage EAB infestations Rehabilitate and restore forest ecosystems Provide funding assistance to Tribes where appropriate

Notification

Contacts

Organization	Address	Phone/fax/e-mail/mobile
Saint Regis Mohawk Tribe Environment Division	449 Frogtown Road Akwesasne, NY 13655	Ph - 518-358-5937 Fax - 518-358-6252 les.benedict@srmt-nsn.gov ken.jock@srmt-nsn.gov
USDA APHIS	USDA-APHIS PPQ 500 New Karner Road, 2nd Floor Albany, NY 12205	Ph - 518-218-7511 Fax - 518-218-7518 Diana.L.Hoffman@aphis.usda.gov Mobile - 518-307-6856
BIA Eastern Region Forestry	Eastern Regional Office Bureau of Indian Affairs 545 Marriott Drive, Suite 700 Nashville, TN 37214	Ph - 615-564-6760 Fax - 615-564-6701 scott.meneely@bia.gov
USFS	US Forest Service Northeastern Area State & Private Forestry, Forest Health Protection 271 Mast Road Durham, NH 03824	Ph - 603-868-7717 Fax - 603-868-1066 nwsiegert@fs.fed.us Mobile - 603-534-7115
NYSDEC	NYS DEC Lands and Forests 625 Broadway Albany, NY 12233	Ph - 518-402-9420 Fax - 518-402-9028 robert.cole@dec.ny.gov
Akwesasne Cultural Center and Museum	Akwesasne Cultural Center 321 State Route 37 Akwesasne, NY 13655	Ph - 518-358-2240 Fax - 518-358-2649 seherne@gmail.com
Mohawk Council of Akwesasne	Mohawk Council of Akwesasne PO Box 579 Cornwall, ON K6H 5T3	Ph - (613) 575-2250 Fax - (613) 575-2181 peggy.pyke@akwesasne.ca
Mohawk Nation Council of Chiefs	MNCC, VIA; PO Box 336, Rooseveltown NY 13683	Ph - (518) 358-3381

Map

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Appendix A

United States Department of Agriculture
Animal and Plant Health Inspection Service
4700 River Road
Riverdale, MD 20737

Permit to Import Timber or Timber Products

Regulated by 7 CFR 319.40

This general permit was generated by the applicant via the APHIS internet portal

PERMITTEE NAME:	**Chief Ron LaFrance Jr.**	**PERMIT NUMBER:**	2014-01 PPQNY General Permit
ORGANIZATION:	**Saint Regis Mohawk Tribe**	**APPLICATION NUMBER:**	N/A – General Permit
ADDRESS:	**412 State Route 37 Akwesasne, NY 13655**	**FACILITY NUMBER:**	N/A – General Permit
MAILING ADDRESS:	**same**	**HAND CARRY:**	Yes
PHONE:	**(518) 358-2272**	**DATE ISSUED:**	**October 6, 2014**
FAX:	**(518) 358-3203**	**EXPIRES:**	*(3 year from issuance)*
PORTS OF ENTRY:	Massena, NY and Ogdensburg, NY		

Under the conditions specified, this general permit authorizes the following:

Article(s):	Countries of Origin	Type of Timber	Bark	Before Import Processing
Ash (*Fraxinus* spp.)	Canada	Logs	Yes	None

PERMIT CONDITIONS

This permit authorizes the importation of the listed articles, under the conditions specified below. A copy of this permit (including all conditions) must accompany all shipments authorized under this permit.

1. This permit shall only pertain to importation of ash logs from non-regulated areas of Canada and movement directly to Akwesasne. An In-Transit Manifest CBP Form 7512b must also be filled out at the Port of Arrival if the logs are destined to Snye or the Saint Regis Village areas.
2. The logs are imported for use in traditional basket-making and must proceed to the Saint Regis Mohawk Tribe's processing facilities/log pounding areas for processing prior to movement into any other area of the United States.
3. Any waste bark stripped from the logs thicker than ½ inch that is not pounded, should be burned or chipped; or buried to a depth of 12 inches or deeper.
4. Ash logs being moved through Canada's Emerald Ash Borer regulated areas must follow Canada's guidelines.
5. The permittee is the legal importer of an article and is responsible for complying with the permit conditions.
6. The PPQ Permit Unit must be informed of a change in contact information for the permittee within ten business days of such change.

END OF PERMIT CONDITIONS

USE OF THIS GENERAL PERMIT IS APPROPRIATE FOR SPECIFIC IMPORTATION OF TIMBER OR TIMBER PRODUCTS.	DATE
Diana Hoffman Diana Hoffman, USDA-APHIS-PPQ State Plant Health Director, Albany NY	10/14/2014

USDA

United States Department of Agriculture

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Office of the
State Plant
Health Director

500 New Karner Rd
2nd Floor
Albany, NY 12205

Voice: 518-218-7510
Fax: 518-218-7518

Federal Relay Service
(Voice/TTY/ASCII/Spanish)
1-800-877-8339

October 16, 2014

The Honorable Chief Ron LaFrance Jr.
Saint Regis Mohawk Tribe
412 State Route 37
Akwesasne, NY 13655

Re: Permit to Import Ash Logs from Canada

Shé:kon/ Dear Chief LaFrance,

On behalf of the United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), I want to thank you for the application to import ash logs from areas near Maniwaki, Québec.

I am pleased to provide a permit authorizing the importation of ash logs from this area of Canada that is free of emerald ash borer (EAB) into your lands near the Port of Massena, effective immediately. USDA-APHIS is issuing this specific permit in order to facilitate the historic and cultural movement of ash and in consideration of the risks.

This authorizes the importation of ash logs, under the conditions cited on the permit. A copy of the permit should be carried by any Tribal representative bringing logs across the border.

I have informed Customs & Border Chief Mr. Raymond Purser at Massena about this permit. PPQ Officer Tom Colarusso is available to facilitate discussion with your representatives and CBP. PPQ and CBP look forward to this collaboration and how we can support the Akwesasne Community's interests and needs.

Thank you for taking the time to develop this application. Feel free to contact me directly, if you have any questions or needs, and I or my staff will be pleased to be of service.

Skén:nen / Peace,

Niawen/Thank You.

Diana Hoffman
State Plant Health Director

cc: Dr. Terry Clark

Memo

To: Tribal Council

From: Les Benedict

cc: Ken Jock

Date: September 24, 2014

Re: Black Ash Importation Permit

As you may be aware the Emerald Ash Borer (EAB) has threatened and also damaged millions of ash trees in the Great Lakes region of US and Canada. Our basket makers depend on black ash for traditional basketry.

In recent years the US Customs and Border protection has inspected black ash logs coming into our territory when log harvesters and basket makers brought them in from Maniwaki. The process that was being used to inspect the logs was confusing and sometimes created unnecessary hostilities and delays at the border. A stop gap measure was instituted for a couple of years that involved certification letters that harvesters took with them in crossing the border. This worked better but wasn't consistent with everyone working at the port of entry.

The Environment Division participated in several meetings over the past few months as well as requested a consultation meeting with the US Department of Agriculture - Animal Plant Health Inspection Service (APHIS) regarding the implementation of a permitting system that they planned on instituting for importation of black ash from Canada. We voiced our concerns that the permitting was burdensome to our community members and asked for a waiver. The waiver was denied. However, the concerns that we raised were elevated by Ms. Dianna Hoffman, USDA-APHIS, NY State Director, to her headquarters in Riverdale, MD.

The result of the effort is the development of a general permit, Plant Protection and Quarantine (PPQ) 585 permit that is much less burdensome to the community than previous versions. We are presenting it to Tribal Council for signature.

Chief Ron LaFrance was involved in our early discussion regarding the importation and permitting issue and is the most versed Tribal Council member regarding the subject. His name is on the permit, although the other Chiefs may wish to also sign it. Chief LaFrance's

name as a matter of practicality is on the permit because his term is for 3 years as is the permit. This arrangement will provide some level of assurances that the knowledge of the permit will transfer through overlapping terms, providing a greater level of historical knowledge.

While we plan on being present during the Tribal Council session when the permits are tabled for signature I wish to make several points regarding the permit and the process.

- The paperwork being submitted for signature is the application. An example of a permit, what it would look like is attached for reference.

- Community members will have to carry a copy of the permit with them when transporting black ash through the border.

- The permit would provide community members desiring to utilize the permit the least amount of delay when bringing black ash across the border.

- Community members utilizing the permit would be subject to other requirements of the permit including other paper work that might be required if transporting from Maniwaki to other parts of the territory, e.g. Snye, Kanatakon.

- Out of consideration for Traditional members or other factions not interested in conforming to the permit provisions, Tribal permit application would in no way compel or infer their requirement to follow the permit. Anyone not utilizing the permit would be doing so through their own choosing.

- The permit is valid for Massena and Ogdensburg ports of entry

- The USDA-APHIS and the US Customs and Border Protection Services have agreed to train and educate their supervisors and inspectors about the permit and the needs of our basket making community, providing sensitivity training on a regular basis so as to capture new hires. They have agreed to accommodate the presence of someone form our community (environment office or other designee) to participate in the sensitivity training to answer questions and offer our insights

- Copies of the permit will be maintained at the Environment Division office during regular business hours to be made available to any community member who wishes to obtain and use one

Question: I have a self certification letter and a copy of a Memorandum from Raymond Purser from 2009, can I continue to use this to bring ash logs in from Maniwaki?

Answer: No, this permit replaces the self-certification letter and Memorandum.

Question: What if problems are encountered while using this permit at the Massena or Ogdensburg port of entry?

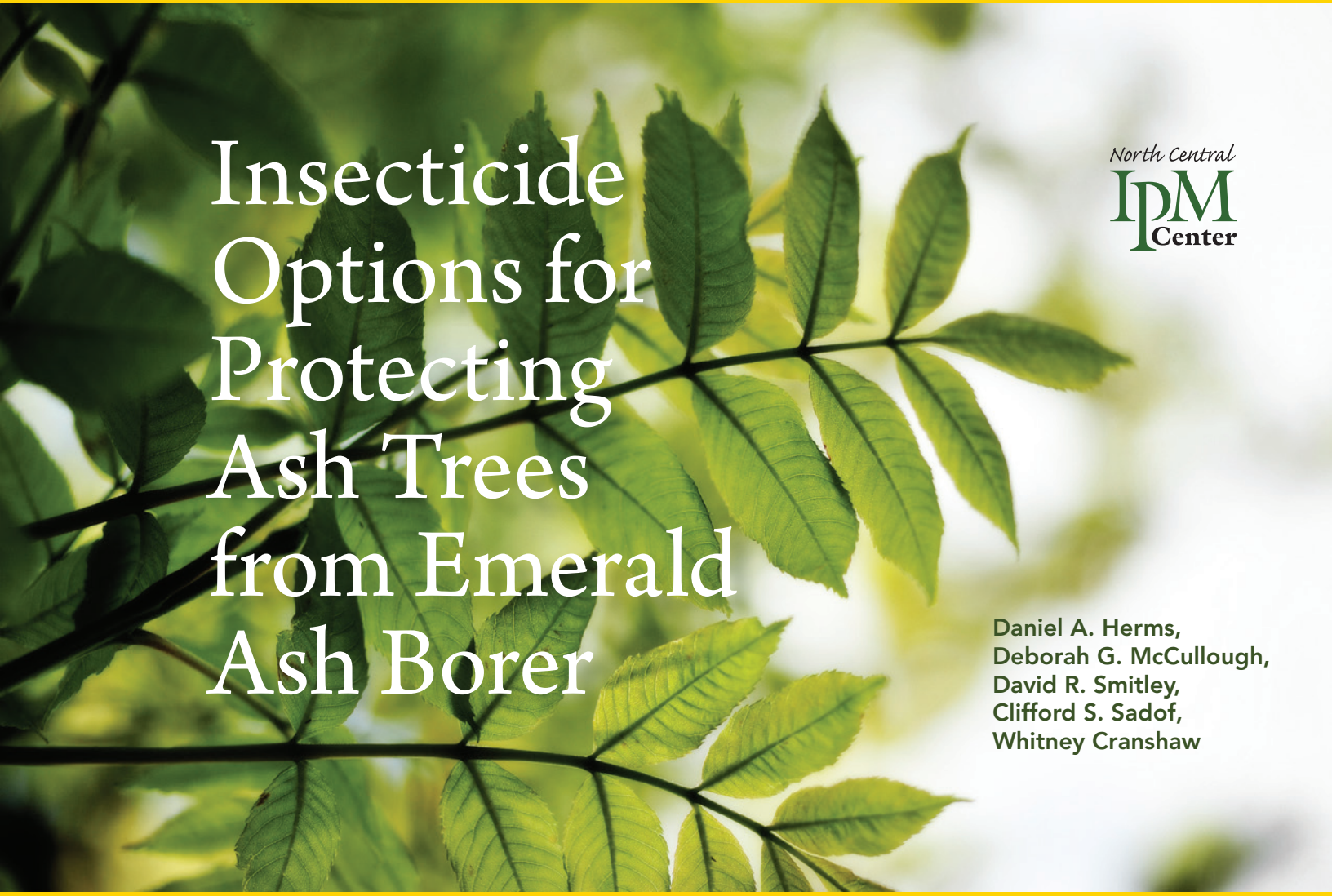
Answer: You may contact the Environment Division Office or the Tribal Council Office during regular business hours, Wetentawén'kie'/Monday-Wiskhaton/Friday 8 am to 4 pm. If the problems are encountered after hours or weekends please obtain as much information as possible regarding the problem such as your name, address, phone number, e-mail address, the officer's name, date, time, nature of problem and contact the Tribal offices the very next business day. The Tribe and the USDA-APHIS will respond to any issues regarding the importation permit as soon as possible.

Key Points to Remember

- The permit holder is the Saint Regis Mohawk Tribe.
- The permittee is Chief Ron LaFrance Jr. because he was recently elected and will be available for the duration of the current permit, three years. This will facilitate a higher level of institutional memory regarding the permit.
- If any unforeseen issues emerge at the port of entry, community members are asked to contact the Environment Division or the Tribal Council offices directly for assistance. Note - offices are not open on weekends and holidays.
- The permit is valid for entry at the Massena and Ogdensburg ports of entry.
- The permit is valid for ash logs (black ash, white ash, green ash).
- Other conditions and requirements within Canada may apply but are not regulated by this permit. Therefore harvesters should check with Canadian officials to determine what additional requirements may exist.
- Waste bark removed from logs once in Akwesasne should be stripped and the bark burned or chipped and buried to a depth of 12 inches or deeper. Note - open burning is regulated by the Tribal Air Quality Program. Community members should contact the Air Quality Program (518) 358-5937 regarding open burning of ash bark.

Appendix B

SECOND EDITION



Insecticide Options for Protecting Ash Trees from Emerald Ash Borer

North Central IPM Center

Daniel A. Herms,
Deborah G. McCullough,
David R. Smitley,
Clifford S. Sadof,
Whitney Cranshaw

The Ohio State University
College of Food, Agricultural, and Environmental Sciences

Michigan State University

Purdue Extension | Local Faces Countless Connections

Colorado State University Extension

SECOND EDITION

Insecticide Options for Protecting Ash Trees from Emerald Ash Borer

Daniel A. Herms[1], Deborah G. McCullough[2], David R. Smitley[3], Clifford S. Sadof[4], Whitney Cranshaw[5]

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Insecticide Options for Protecting Ash Trees from Emerald Ash Borer (Second Edition) is funded in part by the USDA-NIFA North Central Integrated Pest Management Center (Funding Award: 2011-51120-31160).

Contents

Insecticide Options for Protecting Ash Trees from Emerald Ash Borer

Emerald ash borer (*Agrilus planipennis* Fairmaire), an invasive insect native to Asia, has killed untold millions of ash trees (*Fraxinus* species) in urban, rural and forested settings. This beetle was first identified in 2002 in southeast Michigan and Windsor, Ontario. As of April 2014, emerald ash borer (EAB) infestations were known to be present in 22 states as well as two Canadian provinces. Surveys continue and additional infestations will be found as EAB continues to invade North America. Ash trees are common in urban landscapes and residential areas across much of the continental US. Many homeowners, tree care professionals, and municipalities would like to protect valuable ash trees from EAB.

Since 2002, our ability to control EAB and effectively protect ash in the landscape has progressed substantially. Scientists have learned much about this insect and how it interacts with its host trees. New insecticide products and application methods have been developed and tested. Results of field trials have shown that even large ash trees can be effectively and consistently protected over multiple years, even in areas with high densities of EAB. Recent economic analyses have concluded that treating landscape ash trees with effective systemic insecticides is much less costly than removing trees.

Our understanding of how EAB can be managed successfully with insecticides has advanced since this bulletin was initially published in 2009. This version has been revised to address frequently asked questions and reflect the current state of understanding of insecticide options for controlling EAB and their effectiveness. It is important to note that research is an ongoing process. Scientists from universities, government agencies and companies will continue to make discoveries and advance EAB management and ash conservation.

Answers to Frequently Asked Questions

What options do I have for treating my ash trees?

Several insecticide options are available to effectively treat landscape ash trees threatened by EAB. Products listed in Table 1 have been evaluated by university and government scientists in field trials. Keep in mind, however, that controlling insects that feed under the bark with insecticides has always been challenging. This is especially true with EAB because most of our native North American ash trees have little natural resistance to this pest. Effective control of EAB requires some care when selecting an insecticide product and application method to ensure the product is applied at the proper rate and time.

I know my tree is already infested with EAB. Will insecticides still be effective?

It is best to begin using insecticides while ash trees are still relatively healthy. By the time most people notice canopy thinning or dieback, EAB has already caused considerably injury to the vascular system of the tree. An effective insecticide may stop additional damage, but it cannot reverse damage that has already occurred and it takes time for trees to recover. Most insecticides used for EAB control act systemically - the insecticide must be transported within the tree. In other words, a tree must be healthy enough to carry a systemic insecticide up the trunk and into the branches and canopy. Trees are damaged by EAB larvae feeding in galleries under the bark. These galleries injure the phloem and xylem tissue that plants use to transport nutrients and water. A few galleries have only a small effect on most trees. As the EAB population grows and more larvae feed on a tree, however, the galleries interfere with the ability of the tree to transport nutrients and water, as well as insecticides. As a tree becomes more and more infested, the injury becomes more severe. Canopies become thin because fewer leaves can be supported by the tree. Large branches or even the trunk can be girdled and killed by the larval galleries.

Multi-year studies have shown that if more than 50% of the canopy has been killed by EAB or if the canopy appears to be thin and carrying less than half as much foliage as it should, it is probably too late to save the tree. The ability of trees to recover from low to moderate EAB injury can vary, depending on the extent of the damage and which control options are used. Studies have also shown that if the canopy of a tree is already declining when insecticide treatments are initiated, the condition of the tree may continue to deteriorate during the first year of treatment. If treatment is effective, the tree canopy will usually begin to improve in the second year of treatment. This lag in the reversal of canopy decline probably reflects the time needed for the tree to repair its vascular system after the EAB infestation has been reduced.

My ash tree looks fine but EAB has been detected in the vicinity of my property. Should I start treating my tree?

Detecting new EAB infestations and identifying ash trees that have only a few larvae is very difficult. Ash trees with low densities of EAB larvae often have few or even no external symptoms of infestation. In addition, scientists have learned that most female EAB lay their eggs on nearby trees, i.e. within 100 yards of the tree from which they emerged. A few female beetles, however, appear to disperse much further, anywhere from 0.5 miles to 2-3 miles. Therefore, if your property is within 10-15 miles of a known EAB infestation, your ash trees are probably at risk. If your ash trees are more than 10-15 miles beyond an infestation, it is probably too early to begin insecticide treatments. Treatment programs that begin too early waste money and result in unnecessary use of insecticide. Conversely, treatment programs that begin too late will not be as effective.

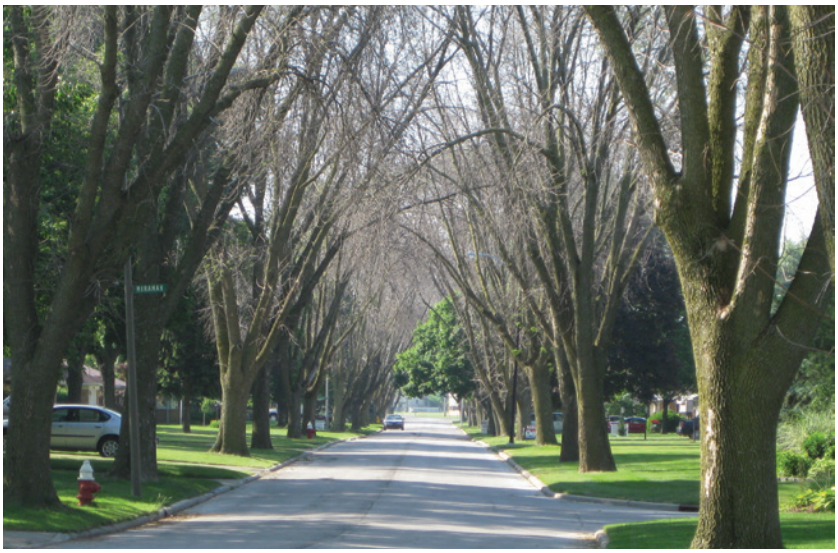
Remember, however, that new EAB infestations have been discovered every year since 2002 and existing EAB populations will build and spread over time. Quarantine maps found on the www.emeraldashborer.info website can help you stay up-to-date regarding locations of known infestations. You can use the links in this website to access specific information for individual states. When an EAB infestation is detected in a state or county for the first time, it will be added to these quarantine maps.

Note, however, that once EAB has been found in a county, surveys by regulatory officials end. Similarly, once an entire state is declared to be infested, regulatory surveys may cease. Therefore, quarantine maps may or may not adequately reflect the current distribution of EAB in such areas. Personnel from city, county or state agencies sometimes continue to survey or monitor local EAB infestations. City foresters, county extension offices or state departments of agriculture may have information on local EAB distribution. There is no substitute for local knowledge and tree care professionals should actively monitor changes in the condition of local ash trees.

When is the best time to treat my trees?

As with any pest management effort, optimal timing is required to achieve best control. Two life stages of EAB are targeted by treatments: adult beetles and young larvae. Therefore, systemic insecticide applications should be made in time to allow for uptake and distribution of the insecticide within the tree to ensure adult beetles and very young larvae encounter the toxin. Non-systemic cover sprays, which are less commonly used, should be applied to foliage to target adult beetles, as well as the trunk and branches to help control newly hatched larvae. Thorough coverage is critical for achieving successful control.

Adult EAB feed on ash foliage throughout their life span and females must feed on leaves for at least 14 days before they begin laying eggs. This provides a window of opportunity to control the adults before any new eggs or larvae are produced. The onset of adult beetle emergence begins from early May (southern Ohio) to early June (central Michigan) and peaks two to three weeks later. Beetle emergence may begin sooner at locales farther south or later in more northern areas. Regardless of location, emergence of adult EAB consistently begins at 450-550 growing degree days, based on a threshold of 50 °F and a starting date of January 1. Beetles are most abundant at about 1,000 growing degree days. Cumulative growing degree days are tracked and posted on websites of many land grant universities as well as the NOAA website. First emergence



Ash trees on a street in Toledo in 2006 and 2009 before and after being impacted by EAB.

of EAB also closely coincides with the period when black locust trees bloom. This phenological indicator is a reliable predictor of EAB emergence across a wide region, ranging from southern Michigan to Kentucky and Maryland.

Peak egg hatch and larval establishment occur between early June and mid-August, depending on location and weather. As a general rule, young larvae are more susceptible to insecticides than are older larvae. Moreover, controlling young larvae prevents damage to the tree caused by older larvae that feed in larger galleries and thus injure more area on the tree. The efficacy of insecticide treatments will likely decline if they are applied later in the growing season when larger, more mature larvae are present. Consistent with this, MSU scientists found that imidacloprid trunk injections made in mid-May were 70% more effective against EAB than those made in mid-July.

For imidacloprid soil treatments, which require four to six weeks for uptake and distribution of the insecticide within the tree, applications should be made in mid-March to late April, depending on your region. Treatments should be applied on the earlier side of these schedules in more southerly locations and later side in more northerly regions. Soil applications of dinotefuran can be applied 2-3 weeks later than imidacloprid because it is more soluble and is taken up and transported through the tree more rapidly. Basal trunk sprays of dinotefuran move into trees even faster and can be made between late May and mid-June. Optimal timing for trunk injected products is just after trees have leafed out, typically from mid-May through early or mid-June. When treating larger trees, treat on the earlier side of the recommended timing, because large trees may require more time for uptake and transportation of the insecticide than small trees. Imidacloprid soil applications can also be made in fall, from mid-October to mid-November. However, this timing is less efficient and studies have shown that higher rates must be applied in the fall than in spring to achieve similar levels of control.

Sometimes, a tree is not known to be infested until in late June or early July. Although late treatments are not optimal, there may still be some benefit to treating the tree if the treatment can be made promptly. Consider using a treatment approach that maximizes rate of uptake and within-tree distribution. Uptake of dinotefuran is faster than imidacloprid because it is more soluble. Basal trunk sprays with dinotefuran will be taken up faster than soil applications (see discussion below). Trunk injections will be taken up faster than soil applications, assuming the injections can be made under favorable conditions (e.g. adequate soil moisture, moderate humidity and air temperature). Even in a best case scenario, it will still likely take one to two weeks for the systemic insecticide to move throughout the tree.

How can I convince my community that action must be taken before it is too late to save the ash trees?

The first step is to educate your community about the threat posed by EAB and the value of the ash trees in the community. Members of some communities have acquired permission to mark ash trees with visual tags. This allows residents to clearly see the extent of the resource at risk. Other suggestions for organizing communities can be found in the "Neighbors Against Bad Bugs" website. You will want to cooperate with your city forester who may already have an inventory of street trees. An inventory will help identify where the ash trees are located, the size and species of the ash trees, and the proportion of the public forest at risk. Some cities use sophisticated inventory systems that even calculate the value of the services provided by the ash trees. In Milwaukee, WI, for example, the capacity of ash trees to filter storm water saves the city more than enough money to justify the cost of treating the trees. Other cities use similar programs to create visible tree tags that tally the dollar value of the services provided by each tree. The National Tree Benefits Calculator website provides information on calculating the value of trees for professional arborists and urban foresters. You may also wish to estimate or compare costs of different management responses to the EAB invasion over time. The EAB Cost Calculator website at Purdue University, for example, allows users to enter their own tree inventory, compare local costs of treatment options or tree removal, and print reports. Links to these websites are available at www.emeraldashborer.info or by using the website name in a google search.

I realize that I will have to protect my ash trees from EAB for several years. Is it worth it?

The economics of treating ash trees with insecticides for EAB protection are complicated and depend on several factors. Tree size, health, location and value should be considered, along with the cost of the insecticide and expense of application, the likelihood of success, and potential costs of removing the trees. Scientists, however, have compared costs of removing urban ash trees versus treating the same trees with emamectin benzoate, which provides two years of EAB control. Results consistently show treatment costs are much lower than removal costs. As treatment options continue to evolve, costs of treatment will likely change. It will be important to stay up to date on these options and management recommendations.

Benefits of treating trees can be more difficult to quantify than costs. Healthy landscape trees typically increase property values, provide shade and cooling, and contribute to the quality of life in a neighborhood. Landscape trees, especially mature trees, capture storm water, reducing potential pollution of streams and rivers. The economic benefits provided by trees increase with the size of the tree, as does the cost of removal. Hence, it may be particularly economical to treat larger trees. Many people are sentimental about their trees. These intangible qualities are important and should be part of any decision to invest in an EAB management program.

It is also worth noting that the size of EAB populations in a specific area will change over time. Populations initially build very slowly, but later increase rapidly as more trees become infested. As EAB populations reach peak densities, a high proportion of the untreated ash trees in a given area will decline and die, usually over a 3-5 year period. Once untreated ash trees in the area succumb, however, the local EAB population will decrease substantially. Ongoing studies in southeast Michigan and northwest Ohio, for example, indicate EAB populations still persist but at much lower densities simply because few mature ash trees remain in this area. Young ash saplings in forests or woodlots will likely be colonized by EAB eventually, so landscape ash may continue to face some risk of EAB infestation. It seems likely, however, that surviving ash trees can be managed with less frequent treatments once the EAB invasion has passed. Studies on the dynamics of EAB populations and whether the intensity of insecticide treatments can decrease after the local EAB population has collapsed are underway in Michigan and Ohio.

My customers want to know about the environmental effects of systemic insecticides used to protect ash trees from EAB.

People often have questions about whether systemic insecticide products used to protect ash trees will harm the environment or other organisms such as woodpeckers. A bulletin entitled "Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used to Control Emerald Ash Borer" is available on the www.emeraldashborer.info website. The 4 page bulletin can be viewed on the website or downloaded and printed for distribution.

Insecticide Options for Controlling EAB

Insecticides that can effectively control EAB fall into four categories: (1) systemic insecticides that are applied as soil injections or drenches; (2) systemic insecticides applied as trunk injections; (3) systemic insecticides applied as lower trunk sprays; and (4) protective cover sprays that are applied to the trunk, main branches, and (depending on the label) foliage.

Insecticide formulations and application methods that have been evaluated for control of EAB are listed in Table 1. Some are marketed for use by homeowners while others are intended for use only by professional applicators. The "active ingredient" refers to the compound in the product that is actually toxic to the insect.

Formulations included in Table 1 have been evaluated in multiple field trials conducted by the authors and other university and governments researchers. Inclusion of a product in Table 1 does not imply that it is endorsed by the authors or has been consistently effective for EAB control. Please see the following sections for specific information about results from these trials.

Strategies for the most effective use of these insecticide products are described below. It is important to note that pesticide labels and registrations change constantly and vary from state to state. It is the legal responsibility of the pesticide applicator to read, understand and follow all current label directions for the specific pesticide product being used.

Using Insecticides to Control EAB

Soil-Applied Systemic Insecticides

Imidacloprid and dinotefuran are systemic insecticides that can be applied as soil drenches or soil injections. Both are sold under numerous brand names for use by professional applicators and homeowners. Those that have been tested by the authors are listed in Table 1; other similar products are also available. Soil applications can applied as a drench by mixing the product with water, then pouring the solution directly on the soil around the base of the trunk, or injected a few inches below ground at multiple locations near the base of the tree. The insecticide is taken up by the roots of the tree and then moves (translocates) throughout the tree.

Products designed for homeowners have some restrictions that do not apply to professional formulations. Homeowner products can be applied as a soil drench or as granules that are watered into the soil, but not as a soil injection. Homeowners are also restricted to making only one application per year.

Professionals can apply these products as a soil injection as well as a soil drench. Soil injections require specialized equipment, but offer the advantage of placing the insecticide below mulch or turf and directly into the root zone of the tree. This also can help to prevent runoff on slopes. Injections should be made just deep enough to place the insecticide beneath the soil surface (2-4 inches). Soil injections should be made within 18 inches of the trunk. Studies have shown uptake is higher and the treatment more effective when the product is applied at the base of the trunk where the density of fine roots is highest. As you move away from the tree, large radial roots diverge like spokes on a wheel and fine root density decreases. Soil drenches offer the advantage of requiring no special equipment for application other than a bucket or watering can. However, imidacloprid can bind to surface layers of organic matter, such as mulch or leaf litter, which can reduce uptake by the tree. Before applying soil drenches, it is important to remove, rake or pull away any mulch or dead leaves so the insecticide solution is poured directly on the mineral soil.

Rates of soil applied insecticides needed to provide effective control may vary depending on the size of the tree and the intensity of pest pressure at the site. Higher rates of some imidacloprid products available to professionals and homeowners can be applied to large trees with trunk diameters greater than 15 inches. Lower rates are effective on smaller trees and when EAB populations and pest pressure are relatively low. When treating larger trees with imidacloprid or dinotefuran soil treatments, particularly when EAB density is high, studies have shown that applying the highest labeled rate is most effective. Only some imidacloprid products can be applied at the higher rate and only if trees are greater than 15 inches in diameter, so please review the label closely when selecting a product.

Treatment programs must also comply with the limits specified on the label regarding the maximum amount of insecticide that can be applied per acre during a given year.

Table 1. Insecticide options for professionals and homeowners for controlling EAB that have been tested in multiple university trials. Some products may not be labeled for use in all states. Inclusion of a product in this table does not imply that it is endorsed by the authors or has been consistently effective for EAB control. Additional imidacloprid products may be available in your area. See text for details regarding effectiveness.

Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
Products Intended for Sale to Professional Applicators			
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Early to mid-spring or mid-fall
Safari ™ (20 SG)	Dinotefuran	Soil injection or drench	Mid- to late spring
Transect ™ (70WSP)	Dinotefuran	Soil injection or drench	Mid- to late spring
Xytect™ (2F, 75WSP)	Imidacloprid	Soil injection or drench	Early to mid-spring or mid-fall
Zylam® Liquid Systemic Insecticide	Dinotefuran	Soil injection or drench	Mid- to late spring
Azasol™	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
Imicide®	Imidacloprid	Trunk injection	Mid- to late spring after trees have leafed out
TREE-äge™	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
TreeAzin®	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
Safari™ (20 SG)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Transect (70 WSP)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Zylam® Liquid Systemic Insecticide	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Astro®	Permethrin	Preventive trunk, branch, and foliage cover sprays	Two applications at 4-week intervals; first spray should occur at 450-550 degree days (50°F, Jan.1); coincides with black locust blooming
Onyx™	Bifenthrin		
Tempo®	Cyfluthrin		
Sevin® SL	Carbaryl		
Products Intended for Sale to Homeowners			
Bayer Advanced™ Tree & Shrub Insect Control	Imidacloprid	Soil drench	Early to mid-spring
Optrol ™	Imidacloprid	Soil drench	Early to mid-spring
Ortho Tree and Shrub Insect Control Ready to Use Granules®	Dinotefuran	Granules	Mid- to late spring

EAB adults must feed on foliage before they become reproductively mature.

This restricts the number of trees that can be treated in an area.

Soil applications should be made when the soil is moist but not saturated. Insecticide uptake will also be limited when soil is excessively dry. You may need to irrigate the soil surrounding the base of the tree before and possibly after the insecticide application if soils are dry. However, water-logged soil can result in poor uptake if the insecticide becomes excessively diluted and can also result in puddles of insecticide that could wash away, potentially entering surface water or storm sewers. To further protect surface and ground water, soil applications should not be made to excessively sandy soils with low levels of organic matter that are prone to leaching, especially where the water table is shallow, or where there is risk of contaminating gutters, lakes, ponds, or other bodies of water.

No soil applications should be made where there are roots of flowering plants that are visited by bees and other pollinators. This situation is most likely to occur where flowering plants are established around the base of an ash tree. In these situations the flowering plants should either be destroyed or insecticide should be applied via trunk injection to ensure the toxins will not be taken up by the flowering plants.

Trunk-Injected Systemic Insecticides

Several systemic insecticide products can be injected directly into the trunk of the tree including formulations of azadirachtin, emamectin benzoate, and imidacloprid (see Table 1). An advantage of trunk injections is that they can be used on sites where soil treatments may not be practical, effective or appropriate, including trees growing on excessively wet, sandy, compacted or restricted soil environments. Trunk injections generally involve drilling through the bark and into the outer sapwood at the base of the tree. Drilling wounds could cause long-term damage, especially if treatments are applied annually. Recent studies of emamectin benzoate (TREE-age™) injected with Arborjet equipment and imidacloprid (Imicide®) injected with Mauget capsules in May, however, showed ash trees rapidly recovered and began producing new wood over the wounds in late summer. Application methods that rely on high pressure injections of insecticide through needles inserted into small holes may damage the tree if the pressure causes the bark to bulge and separate from the cambium. This is most likely to occur in spring and can cause larger wounds that result from death of the vascular tissue at the point of separation.

Products applied as trunk injections are typically absorbed and transported within the tree more quickly than soil applications. Allow at least two and preferably three to four weeks for most trunk-injected products to move through the tree. Optimal timing of trunk injections occurs after trees have leafed out in spring but before EAB eggs have hatched, or generally between mid-May and mid-June. Uptake of trunk-injected insecticides will be most efficient when trees are actively transpiring. Best results are usually obtained by injecting trees in the morning when soil is moist but not saturated. Uptake will be slowed by hot afternoon temperatures and dry soil conditions. Irrigating trees during droughty conditions will help with insecticide uptake and translocation within the tree.

Noninvasive, Systemic Basal Trunk Sprays

Dinotefuran is labeled for application as a noninvasive, systemic trunk spray for EAB control. It belongs to the same chemical class as imidacloprid (neonicotinoids) but is much more water soluble and moves more readily through plants. The formulated insecticide is sprayed on the lower five to six feet of the trunk using a common garden sprayer and low pressure. Research has shown that the insecticide penetrates the bark and is transported systemically throughout the tree.

The basal trunk spray offers the advantage of being quick and easy to apply and requires

no special equipment other than a garden sprayer. This application technique does not wound the tree, and when applied correctly, the insecticide does not enter the soil. Sprayers must be calibrated to ensure the appropriate amount of the formulated product is applied to each tree.

Dinotefuran can be mixed with surfactants that may facilitate its movement into the tree, particularly on large trees with thick bark. However, in field trials, adding a surfactant did not consistently increase the amount of insecticide recovered from the leaves of treated trees or improve the effectiveness of the application.

Protective Cover Sprays

Insecticides can be sprayed on the trunk, branches and (depending on the label) foliage to kill adult EAB beetles as they feed on ash leaves, and newly hatched larvae as they chew through the bark. Thorough coverage is essential for best results. Products that have been evaluated as cover sprays for control of EAB include some specific formulations of permethrin, bifenthrin, cyfluthrin and carbaryl (see Table 1).

Protective cover sprays are designed to control EAB adults and perhaps very young larvae that have just hatched from eggs. Sprays will have no effect on larvae feeding under the bark. Cover sprays should be timed to occur when most adult beetles have emerged and are feeding on ash leaves. For best results, consider two applications, one at 500 DD_{50} (as black locust approaches full bloom) and a second spray four weeks later.

How Effective Are Insecticides for Control of EAB?

Extensive testing of insecticides for control of EAB has been conducted by researchers at Michigan State University (MSU) and The Ohio State University (OSU). The following sections summarize key results of these trials.

Keep in mind that maintaining good growing conditions and avoiding major stresses will improve your chances of successfully protecting your trees. Be sure to water trees during extended dry periods.

Soil-Applied Systemic Insecticides

Efficacy of soil-applied systemic insecticides for controlling EAB has been inconsistent. In some OSU and MSU trials, EAB control was excellent, while others yielded poor results.

Healthy ash trees that have been protected with imidacloprid soil drenches in 2009 growing next to untreated ash trees injured by EAB. The same street in 2011 following six consecutive years of treatments during a peak EAB outbreak. Untreated trees declined and were removed.

EAB larvae damage the vascular system of the tree as they feed, which interferes with movement of systemic insecticides in the tree.

Application protocols and conditions of the trials have varied considerably, making it difficult to reach firm conclusions about sources of variation in efficacy. This inconsistency may reflect the fact that application rates for soil-applied systemic insecticides are based on amount of product per inch of trunk diameter or circumference. As the trunk diameter of a tree increases, the amount of vascular tissue, leaf area and biomass that must be protected by the insecticide increases exponentially. Consequently, for a particular application rate, the amount of insecticide applied as a function of tree size is proportionally decreased as trunk diameter increases. Hence, application rates based on diameter at breast height (DBH) may effectively protect relatively small trees but can be too low to effectively protect large trees. Some systemic insecticide products address this issue by increasing the application rate for large trees.

Some imidacloprid formulations can be applied to trees with a trunk diameter greater than 15 inches at a rate that is twice as high (2X rate) as the rate used for smaller trees (1X rate). In an OSU study in Toledo, Ohio underway since 2006, imidacloprid soil drenches have effectively protected ash trees ranging from 15-22 inches in diameter when applied at the 1X rate in spring, or at the 2X rate when applied in spring or fall. These treatments were effective even during years of peak pest pressure when all of the untreated trees died. Trees treated in fall with the 1X rate, however, declined and were removed. In another OSU multi-year trial with trees up to 22 inches DBH, dintotefuran soil applications, as well as basal trunk sprays (see below) were effective when applied at the highest labeled rate. However, lower rates were less effective. We are not aware of any studies that evaluated soil applied insecticides with trees larger than 22 inches DBH.

Insecticide placement may also affect efficacy. Recent studies have shown that soil drenches and injections made at the base of the trunk result in more effective uptake than applications made on grid or circular patterns under the canopy away from the trunk.

Trunk-Injected Systemic Insecticides

Emamectin benzoate • In several intensive studies conducted by MSU and OSU researchers, a single injection of emamectin benzoate (TREE-äge™) in mid-May or early June provided excellent control of EAB for at least two years, even when EAB densities were high. For example, in a highly-replicated study conducted on trees ranging in size from 5 to 21-inch DBH at three sites in Michigan, untreated trees had an average of 68 to 132 EAB larvae per m^2 of bark surface, which represents high pest pressure. In contrast, trees treated with low rates of emamectin benzoate (0.1-0.2 g ai / inch DBH) had, on average, only 0.2 larvae per m^2, a reduction of >99 percent. When additional trees were felled and debarked two years after the emamectin benzoate injection, there were still virtually no larvae in the treated trees, while adjacent, untreated trees at the same sites had hundreds of larvae.

In two Ohio studies with street trees ranging in size from 15- to 25-inch DBH, a single application of emamectin benzoate provided excellent control for two years, even at the lowest rate. There was no sign of canopy decline in treated trees and very few emergence holes, while the canopies of adjacent, untreated trees exhibited severe decline and extremely high numbers of emergence holes. In another trial, large trees, ranging from 32 to 47 inches DBH, were treated in alternate years with emamectin benzoate at medium-low or medium-high rates. Canopies of all treated trees remained healthy four years later (after two treatments) despite high pest pressure and numerous declining (untreated) trees in the immediate vicinity.

Additional studies have been conducted since then in other sites and all have produced similar results. Injections of emamectin benzoate, even at the lowest rate on the label (0.1 ga ai/DBH inch), provide nearly complete EAB control for two years. Depending on application rate and pest pressure, treatment with emamectin benzoate may

even protect trees for three years. Moreover, in side-by-side comparisons, emamectin benzoate was more effective than other systemic neonicotinoid products.

Azadirachtin • Results from a two-year study in Michigan replicated at three sites showed azadirachtin products affect EAB differently than other insecticide products. For example, adult EAB beetles fed for six days on leaves from trees treated with a high rate of azadirachtin (TreeAzin®), then fed on leaves from untreated trees for the remainder of their life span. In contrast to trees treated with either emamectin benzoate (trunk injection) or dinotefuran (basal trunk spray), leaves from the azadirachtin trees were not acutely toxic to adult beetles. However, azadirachtin reduced the ability of mature female beetles to produce viable eggs that successfully hatched. Young females, conversely, appeared to recover and were able to reproduce normally.

When the trees in this study were felled and debarked after two years of exposure to EAB, it was apparent that numerous EAB larvae had begun feeding on trees treated with TreeAzin but died while still young and small. Very few live larvae were present on the trees treated in both years with TreeAzin. When trees were treated only the first year but not the second year, density of live larvae was 75-80% lower than on untreated control trees. Results from this study suggest that in most years, TreeAzin will effectively protect ash trees for two years, but when EAB densities are high, annual applications may be prudent.

Imidacloprid • Trunk injections with imidacloprid products have provided varying degrees of EAB control in trials conducted at different sites in Ohio and Michigan. In an MSU study, larval density in trees treated with Imicide® injections were reduced by 60 percent to 96 percent, compared to untreated controls. There was no apparent relationship between efficacy and trunk diameter or infestation pressure. In another MSU trial, imidacloprid trunk injections made in late May were more effective than those made in mid-July, and IMA-jet® injections provided higher levels of control than did Imicide®, perhaps because the IMA-jet® label calls for a greater amount of active ingredient to be applied on large trees. In an OSU study in Toledo, IMA-jet® provided excellent control of EAB on 15- to 25-inch trees under high pest pressure when trees were injected annually. However, trees that were injected every other year were not consistently protected.

In a discouraging study conducted in Michigan, ash trees continued to decline from one year to the next despite being injected in both years with either Bidrin (Inject-A-Cide B®) or imidacloprid. The imidacloprid treatments consisted of two consecutive years of Imicide® (10% imidacloprid) applied using Mauget® micro-injection capsules, or an

Healthy ash trees protected with emamectin benzoate trunk injections behind an untreated, declining tree.

experimental 12% formulation of imidacloprid in the first year followed by Pointer™ (5% imidacloprid) in the second year with both applied using the Wedgle™ Direct-Inject™ System. All three treatment regimens suppressed EAB infestation levels in both years, with Imicide® generally providing best control under high pest pressure in both small (six-inch DBH) and larger (16-inch DBH) caliper trees. However, larval density increased in treated and untreated trees from one year to the next. Furthermore, canopy dieback increased by at least 67 percent in all treated trees (although this was substantially less than the amount of dieback observed in untreated trees). Even consecutive years of these treatments only slowed ash decline under severe pest pressure.

In a head-to-head comparison of products conducted by OSU researchers, emamectin benzoate trunk injections (0.4 g a.i. / inch DBH applied during the first year in May) and imidacloprid soil drenches (applied in both years in May at the highest labeled rates) provided effective control of EAB. In contrast, trees treated with Pointer™ (5% imidacloprid applied in both years in May at the highest labeled rate) and the untreated trees declined substantially over the two year study period. In another MSU study, ACECAP® trunk implants (active ingredient is acephate) did not adequately protect trees > 15-inch DBH under high pest pressure.

Noninvasive Systemic Basal Trunk Sprays

Studies to date indicate that the effectiveness of dinotefuran basal trunk sprays are similar to soil applications of dinotefuran or imidacloprid. MSU and OSU studies have evaluated residues in leaves from trees treated with the basal trunk spray. Results show that the dinotefuran effectively moved into the trees and was translocated to the canopy at rates similar to those of other trunk-injected insecticides, and faster than other soil-applied neonicotinoid products.

As with imidacloprid treatments, control of EAB with dinotefuran has been variable in research trials. In an MSU study conducted in 2007 and 2008, annual dinotefuran trunk sprays reduced EAB larval density by approximately 30 to 60 percent compared to the heavily infested untreated trees. As with dinotefuran and imidacloprid soil applications, the basal trunk treatment was effective for only one year and would have to be applied annually.

In a five-year OSU study with trees up to 22 inches DBH, dinotefuran basal bark sprays provided effective protection when applied at the highest labeled rate (average of less than 5% canopy decline compared with nearly 80% average canopy decline for untreated trees). A lower rate was not as effective (almost 20% average canopy decline).

Protective Cover Sprays

MSU studies have shown that applications of Onyx™, Tempo® and Sevin® SL provided good control of EAB, especially when the insecticides were applied in late May and again in early July. Acephate sprays were less effective. BotaniGard® (*Beauvaria bassiana*) was also ineffective under high pest pressure. Astro® (permethrin) was not evaluated against EAB in these tests, but has been effective for controlling other species of wood borers and bark beetles.

In another MSU study, spraying Tempo® just on the foliage and upper branches or spraying the entire tree were more effective than simply spraying just the trunk and large branches. This suggests that some cover sprays may be especially effective for controlling EAB adults as they feed on leaves in the canopy. A single, well-timed spray was also found to provide good control of EAB, although two sprays may provide extra assurance given the long period of adult EAB activity.

It should be noted that spraying large trees is likely to result in a considerable amount of insecticide drift, even when conditions are ideal. Drift and potential effects of insecticides on non-target organisms should be considered when selecting options for EAB control.

Key Points and Summary Recommendation

- Insecticides can effectively and consistently protect even very large ash trees from EAB, even under intense pest pressure.
- Drought stress inhibits uptake and transport of systemic insecticides. Supplemental irrigation will be needed during dry periods.
- Unnecessary insecticide applications waste money. However, EAB infestations are very difficult to detect when populations are low. Once EAB has been detected within 10-15 miles, your trees may be at risk. Be aware of the status of EAB in your location. Current maps of counties and states where EAB has been found are available at www.emeraldashborer.info. Remember, however, that once a county is quarantined, regulatory surveys end and maps for that county are no longer updated. In some areas, local information on EAB infestations may be available from city, county or state officials.
- Trees exhibiting more than 50 percent canopy decline (thinning or dieback) are unlikely to recover even if treated with a highly effective systemic insecticide. Trees that are already infested and showing signs of canopy decline when treatments are initiated may continue to decline the first year after treatment, and then begin to improve the second year, as the trees recover. Effectiveness of products varies and depending on the product applied and the pest pressure, trees with lower levels of canopy decline may not recover despite treatment.
- Emamectin benzoate consistently provides at least two years of EAB control with a single application, even in large and very large trees under intense pest pressure. It also provided a higher level of control than other products in side-by-side studies.
- Trunk injections of azadirachtin affect EAB differently than other systemic insecticides. Results from a recent study indicate azadirachtin should provide effective protection for one to two years, depending on EAB pressure.
- Basal trunk sprays with dinotefuran applied annually effectively protected ash trees up to 22 inches DBH in several studies. It is important to calibrate sprayers to ensure the proper rate of the formulated product is applied.
- Imidacloprid and dinotefuran soil applications provided effective EAB control of trees up to 22 inches DBH (larger trees were not tested) when applied annually at the highest labeled rate, even under intense pest pressure. Soil drenches and injections are most effective when the product is applied at the base of the trunk. Generally, imidacloprid soil applications are more effective when applied in the spring than in the fall. Soil injections should be no more than 2-4 inches deep, to avoid placing the insecticide beneath feeder roots of the tree. To facilitate uptake, systemic trunk and soil insecticides should be applied when the soil is moist but not saturated or excessively dry.
- When treating trees greater than 15 inches DBH with imidacloprid soil applications, select a product that allows a higher rate (2X rate) to be used. Not all imidacloprid products can be applied at that rate, so check the label carefully. Users must comply with all restrictions on the frequency of applications and the amount of insecticide that can be applied per acre in a given year.

The Cooperative Emerald Ash Borer Program

For more information and to download additional copies of this bulletin:

www.emeraldashborer.info/

The Ohio State University EAB Outreach Team

www.ashalert.osu.edu

Purdue Extension

www.eabindiana.info

Colorado State

www.ext.colostate.edu/pubs/insect/emeraldashborer

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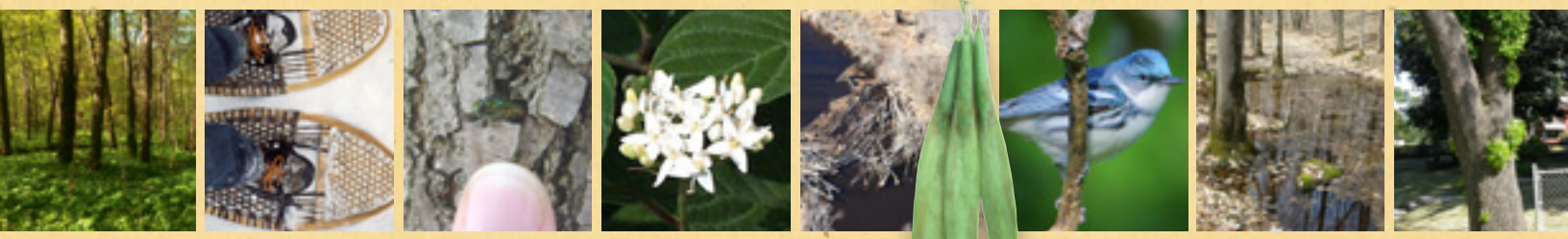

Ash Management Guidelines

for Private Forest Landowners

A project of the
University of Minnesota
Extension and the Minnesota
Department of Natural Resources

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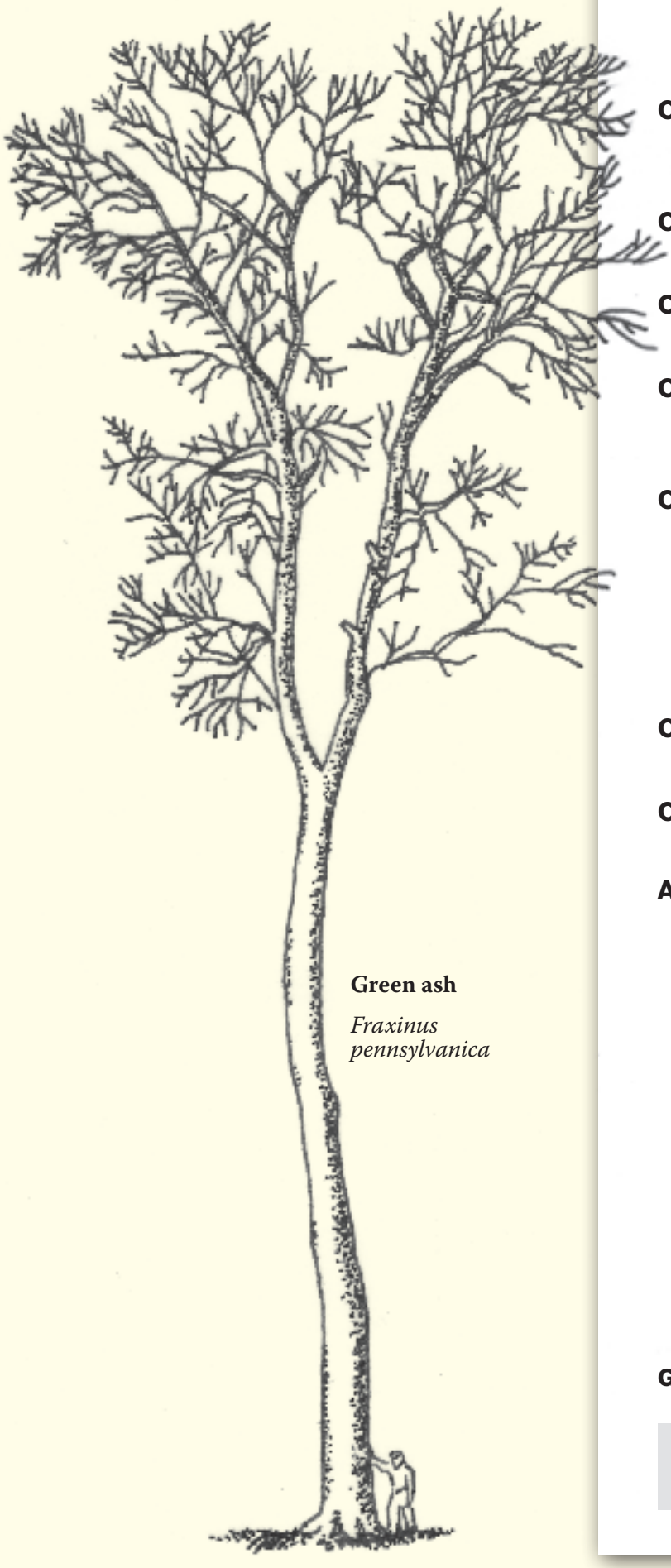

Green ash

Fraxinus pennsylvanica

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General Ash Management Guidelines

Introduction: Walking the Talk

There is a lot of talk about how to manage Minnesota's ash trees. The 'talk' has become the focal point of professional management discussions and policies, as well as the news around the breakfast tables of those who own nearly 50 percent of the forested land in the state: YOU, the private forest landowner.

Natural resource professionals reviewed ash management recommendations, including those for state land, developed by the Minnesota Department of Natural Resources (Appendix A). Those resources professionals wanted to offer you, the family forest landowner, another approach. This Guide will discuss some specific guidance on ash management. It was developed cooperatively with insight from many different fields related to forestry and ecosystem management. A detailed, multi-process survey allowed experts to apply their knowledge several times to offer useful management tips for the complicated and unprecedented future that faces Minnesota's forests. As a result of this effort there are some basics you should use as the foundation to build upon in your management decisions.

The following are a few baseline tips shared by a diversity of public and private professional resource managers:

- Seek and use the advice of a professional forester/forest plan writer.
- Closely monitor stands with ash.
- Plan for forest conversions when ash is a major component of your forest.
- Work with neighboring landowners to address threats on a larger scale.
- Actively discourage invasive plant and insect species; manage for native species.
- Think outside the box. Contemplate a wider choice of tree species appropriate to your sites and needs. Diversify the species you select. Tree and plant diversity will help prevent future large-scale mortality the next time we discover a major pest attacking a tree species.
- Think about replacement tree species before the ash dies.
- Underplanting. Consider planting shade-tolerant trees beneath canopies of existing trees.
- Minimize harvest damage by using the services of a professional logger who has taken training with the Minnesota Logger Education Program. Ask for credentials and references.
- Keep in mind - you can't call a logger and expect him/her to be out harvesting at your site in the next week or month. In most cases, you are going to need to set the plans in motion 2-3 years before the timber is harvested.
- Be extremely careful if using heavy equipment on very wet sites. It may be best to leave the ash alone in these areas.
- Be familiar with, and apply Best Management Practices.

Following is a detailed background of ash as a resource, ash tree identification, emerald ash borer information and identification, and ash in our woodlands and recommendations on how to manage ash forests through this transition. We hope this Guide is useful and informative as we face this unprecedented forest change together.

The Delphi Survey Process

The University of Minnesota Extension and the MN Department of Natural Resources (DNR) recognized a need to offer practical and timely ash management recommendations for family forest landowners in the emerald ash borer (EAB) era. However because EAB is such a new pest, first discovered in Michigan in 2002, and trees grow slowly – the average life span of an ash is 200 years – and science takes time; we were tasked with the nearly impossible: to predict the future. We did our best to make recommendations to manage for this uncertainty. Extension took the lead in exploring options on the best way to predict and plan for an unknown future. After much consideration and consultation with Extension's evaluation experts, a survey process called a modified-Delphi was chosen. This process is a systematic, interactive, anonymous, structured survey method to facilitate a panel of experts to offer recommendations or opinions from many areas of expertise.

For this Ash Management project Extension facilitated three rounds of the modified-Delphi survey. Of the 31 participants not all participated in each round. This process was extensive, Round 1 (84% response rate), consisted of 19 open end questions. Participants were given two weeks to contribute to the survey. Following those two weeks Extension had two weeks to tally survey responses and create the next round of the survey based on feedback offered in the previous round. Round 2 (81% response rate) was large, 103 questions all generated from Round 1. Round 3 included all the results from Round 2 plus new information generated in Round 2. In total, Round 3 (68% response rate) was 98 questions. The results of this survey process are wide reaching, but they are not exhaustive. When consensus couldn't be reached we didn't report that recommendation. It is very important to remember that none of us has a crystal ball which we can see the future of Minnesota's ash forests. This is our best effort to find a method and experts to offer help. However it will be very important for everyone, landowners and natural resource professionals alike, to stay abreast of current research and information because recommendations are likely to change as the sciences catches up.

Forty-one experts, mostly from Minnesota, were asked to participate. They were experts in silviculture, forest hydrology, the MN DNR's ecosystem classification system, timber harvesting, family forest landowners, forest regeneration, forests and climate change, wood utilization and logging, forest wildlife, woodland communication, EAB quarantine, EAB, cultural aspects of ash, and forest genetics. Deliberate effort was made to find experts from different organizations including the University of Minnesota, DNR, US Forest Service, private industry, Bureau of Indian Affairs, Minnesota counties, and private landowners. However, survey facilitators had little control over who actually participated in the survey. Of the 41 invited to participate 31 actually contributed in any of the three rounds. All response rates are based on the 31 experts that actually participated in at least one of the rounds.

Funding and resources for this project, beyond the valuable and extensive time contributed by the panel of experts, were offered by the University of Minnesota Extension, the MN Department of Natural Resources, Forest Stewardship Funding, and the Renewable Resources Extension Act.

In order to clearly offer you, the reader, with a quick way to assess the difference between important resource information and recommendations generated from the survey, all Survey Recommendations will be featured in these eye catching call-out boxes. Although attributed to an individual, these recommendations in the call-out boxes were approved by group consensus using the modified-Delphi process.

Suggestions from the experts during the Survey

- It is important to remember that for all ash stands considered in this survey: The effects of global climate change are too variable to make stand level decisions.
- Landowners should minimize harvesting damage; harvest using current Best Management Practices; and unless otherwise noted, harvest using current standard silvicultural practices; recognize that new practices may be developed and landowners should stay abreast of new research.
- A quarantine expert commented: "These may need to be modified for mostly pure ash stands. If EAB infestation is widespread or imminent, damage to residual timber, snag tree retention guidelines, and clearcut acreage limitations might not be important when compared to the alternative."
- Additionally, landowners should actively discourage invasive species. They should manage for native species while preparing for an increase in secondary insects and disease on dying ash and a decrease in total stand biodiversity and changes in wildlife species using the stand.
- One expert pointed out it's very important for landowners to stay aware of where EAB is in the state. One expert on landowner communication stated, "I favor strongly encouraging management when feasible (e.g., removal of ash in conjunction with other harvests.)"
- "We should emphasize to family forest owners that change is coming and using some of the wood would be good rather than letting it all die and rot."
- Along that same line an entomologist stated, "The goal should be to think about replacement before the ash dies because that is when the landowner has the best hopes of influencing the results."
- A general rule of thumb for landowners should be to remove dead/dying ash trees. "If the trees are in an area where the falling trees will be a hazard to people or property then they should be removed, or at least cut down," according to one entomologist.
- Ash mortality will cause hazards to recreational trails.
- Landowners should begin now to assess the threat to their land, map out a management strategy and take action to get that implemented.
- Efforts to leave some ash for genetic stock are more likely to survive if "neighboring threats are reduced."
- Leave a mixture of qualities and species of ash trees for genetic diversity.
- One forest geneticist said, "If (a) harvest is in advance of EAB or far from proximity of infection point. This allows for retention of species and genetic diversity in event that EAB is controlled."
- Another entomologist pointed out, "There are trees that have escaped attack in southeastern Michigan – we don't know why they have escaped attack - it is possible that a variety of modes of resistance to EAB attack are present in the gene pool."
- On the bright side, one expert mentioned: After ash morality has occurred berry product in small shrubs and trees may increase. Raspberries, highbush cranberries, Juneberries would all be stimulated by increased sunlight.

The Emerald Ash Borer & Chestnut Blight: A historical perspective

If you have been a Minnesota resident during the past half century, you likely remember the 'great depression' of community trees when Dutch Elm disease took its toll. Boulevard trees, back yard trees, and trees along parkways and riverwalks had to be removed because of this disease that virtually wiped out the state's elm tree population. There are lessons to be learned. Read on.

Emerald ash borer is often compared with Dutch elm disease. There are good reasons for this comparison. Minnesotans have a cultural memory of the decline and loss of American elm in our cities. Dutch elm disease was first discovered in St. Paul in 1961, with massive death of the trees and removal not occurring until the 1970s. Many communities replaced at least some of their lost elms with ash. So it is natural to make the comparison of emerald ash borer (EAB) to Dutch elm disease, particularly in our cities. But is that really a good comparison?

Let's look further back into our forest's history for a different example: chestnut blight and the loss of American chestnut (*Castena dentata*). Chestnut blight led to the first large scale loss of a forest tree. American chestnut is a large, stately native tree found from Maine to Mississippi. It succumbed almost completely to chestnut blight between 1900, when the blight was first discovered in New Year City, and 1940 when the blight had invaded all the commercial stands of eastern chestnut and killed most of the trees.

So what is the impact of these pests on the forest? Emerald ash borer attacks and kills virtually all ash (*Fraxinus spp.*) trees greater than 1" in diameter. Chestnut blight, while not actually killing all the trees, reduced the presence of the American chestnuts in the Appalachian forest to small bush-like sprouts growing from the truck and roots of formerly majestic and dominate trees. This species is functionally lost to our forests.

Dutch elm disease, on the other hand, has a mortality rate of about 80%. While elm now makes up a significantly smaller percent of our urban and forested trees than before Dutch elm disease invaded, elm still exists in urban environments largely because of fungicidal treatments. In forested environments, it remains as a small understory tree. This situation is very different than the functionally nonexistent American chestnut in the eastern forest. Additionally it is important to look at the actual spread rate of these pests. Chestnut blight spread and killed chestnut trees at 32-40 km/year (Tainter & Baker, 1996). Actual spread rates for Dutch elm disease are harder to find, but it was first identified in Ohio in 1930 and eventually arrived in St. Paul, Minnesota in 1961. Even then, the first seven years it was in St. Paul there were only 30 reported cases.

Emerald ash borer, on the other hand, was first reported in Detroit, Michigan in 2002 – although dendrochronological analysis places the insect there as early as the mid-1990s (Siegert, McCullough, Liebhold, Telewski, 2008). Dendrochronology is the science of dating trees, and associated environmental events, using a tree's growth rings. In this circumstance, researchers in Michigan took ash trees from various locations throughout southeastern Michigan, dated their growth rings, and noted the year of attack by EAB. They then cross referenced that data with weather patterns to better assess when EAB first arrived in Michigan.

Although its "first date" in the United States is still unknown, we do know EAB was here years before it was identified and reported, and before management and quarantines were started.

In a time span of about 15 years, EAB has spread to 14 states from Minnesota to Virginia and Missouri to New York. Unlike chestnut blight, Dutch elm disease and EAB are being spread long distances in similar ways, mainly via human transportation of wood materials. Chestnut blight was spread predominately through natural movement. The future prospect for ash is not bright. Data from Michigan indicates there is little residual ash in a stand after EAB has attacked an area, and the ash seed bank survives only up to eight years. Scientists and volunteers have been working to collect and preserve ash genetic material in Minnesota for years so that science will have genes from which to work after EAB has come through.

Ash trees comprise over 50% of some stands in northern Minnesota. Conversely, elm, while an important tree species in several forest types, was almost never a majority of the trees in a stand. And, in some forest stands in Appalachia, American chestnut comprised 25% of the trees. Therefore the stand-level impact of Dutch elm disease was likely less than the anticipated stand-level impact of EAB in some ash dominated sites in northern Minnesota. However, interestingly, ash now comprises a higher percent of some Minnesotan timber types than ever before, likely due to the loss of elm. Ash filled the ecologic niche created when the elm died. It is ironic that one of the ten tree species in seven of the nine timber types by geography recommended in this Guide is the introduction of disease resistant American elm to replace ash. One could conjecture that the forest is coming full circle; one invasive species removed most elms from the forest to the benefit of ash, now another invasive species will remove ash to the potential benefit of disease resistant elm.

In summary, while Dutch elm disease was and is a major forest pest in Minnesota and was devastating for both the urban and forested elms, emerald ash borer is likely to be an even bigger problem. It is expected to hit certain forest stands much harder than Dutch elm disease did – likely more on the scale of American chestnut – something for which we have virtually no living cultural memory.

It is important to remember, however, that science is moving faster than ever and genetic research has progressed markedly since the turn of the century. Foresters are now beginning to plant blight resistant American chestnuts in the forests of Appalachia, and there are disease resistant American elms we can replant in our forests. With careful monitoring, the help of science, and supportive funding the forest can grow again.

For References, See Appendix D, page 66

Chapter 1

Page 6: Black ash near Two Harbors, Minnesota

A History of Minnesota's Ash Resource

Current Extent and Abundance of Ash

Ash is one of the most widely distributed plants in Minnesota.

All 87 counties in the state have one variety of ash or another. There are three ash species in the state: black, green, and white. Ash is found in all terrestrial native habitats, and it is widely planted in yards and along boulevards.

The current ash population in Minnesota is about 176 million trees, some 8.6 percent of all forestland trees (>5" ***diameter at breast height –"dbh"***). Ash is a significant tree on 866,000 acres of forest land. In a little more than half of these forests (463,000 acres, 53%) ash is just a component of the forest, mixed most often with other ***deciduous*** trees. However, ash is the dominant and sometimes the only tree on some 406,000 acres of land. Losing ash to emerald ash borer (EAB) on these lands will be obvious and locally devastating. The population of small, regenerating ash (1-4" dbh) is incredibly high – roughly 795 million ash or roughly 5 saplings per every ash tree. If one were to consider also germinating ash (<1") there are billions if not 10s of billions of ash individuals in the state. This is so because ash is ***shade tolerant*** and its ecological strategy is to build a large store of seedlings beneath a ***canopy*** – each seedling hoping to be the lottery winner that replaces a canopy tree.

Perhaps the most striking fact about ash is that it is far more widespread as small seedlings than as trees. In other words, small ashes are often abundant in environments where ash trees rarely survive. Green ash, in particular, is constantly invading open space – including native prairies, some marshes, wet meadows, and open peatlands. Even in the forest, it is common to encounter ash seedlings and saplings without a parent tree in sight. Young, regenerating ash are, simply, everywhere.

GLOSSARY

dbh: *Diameter at breast Height: The diameter of the stem of a tree measured at breast height (4.5 ft or 1.37 m) from the ground. On sloping ground the measurement is taken from the uphill side.*

deciduous: *Perennial plants that are normally more or less leafless for some time during the year.*

shade tolerant: *Having the capacity to compete for survival under shaded conditions.*

canopy: *The foliage cover in a forest stand consisting of one or several layers.*

Photo: Eli Sagor

Historic Abundance and Change in Abundance of Ash in Minnesota

The history of ash in Minnesota is "old as dirt" – literally. Black ash was among the hardy pioneers to occupy fresh soil while glacial ice slowly melted from the landscape some 16,000 to 11,500 years ago. We know this because black ash pollen is preserved along with the pollen, wood, and leaves of other trees in the oldest sediments of our lakes. The assemblage of plant fossils includes abundant remains of spruce, with lesser amounts of ash, tamarack, fir, sage, ragweed, grasses, and sedges.

Most ***paleoscientists*** agree that this assemblage of fossil plant communities has no analogue in the modern vegetation of North America. Even where we have glaciers, we don't see this particular combination of plants. This suggests that the climate of the late-glacial period in Minnesota and the American Midwest, was unique to that time. Ice cores from Greenland tell us that the temperature fluctuated during that time; scientists debate about the strength of seasonality – but everyone agrees that it was wet. It is no stretch for a botanist to imagine spruce, black ash, tamarack, fir, grasses, and sedges occurring in wet habitats because they occur in such places today. The amount of ash pollen in late glacial sediments (~10-15 percent) is the most that we see in any lake sediments from Minnesota. When Minnesota was ice-free and experiencing a much warmer climate (the modern Holocene Epoch), other native trees eventually migrated into the state. Competition with these new species, the maturation of soils, and considerably drier conditions helped to diminish ash populations. Sediments younger than about 11,000 years have little ash pollen, but it is steadily present. Apparently, the wet forest niche that favors ash has been a stable component of Minnesota's landscape since the glaciers were here. Before the arrival of EAB and concern of global warming, the 11,000-year pollen record assured Minnesotan's of an ash resource.

White settlers have significantly impacted ash populations during the course of settlement and agricultural development of Minnesota. When settlers first

GLOSSARY

paleoscientist: *Scientists who study organisms of the past.*

Photo: Michael Lee

Shown here is a Floodplain Forest, referred to in the Native Plant Community classification as an "FF."

Photo: Bill Swindaman

The habitat of the green heron is small wetlands in low-lying areas. The species is most conspicuous during dusk and dawn. They prefer to be active at night, retreating to sheltered areas during the daytime.

arrived in the state, ash was a component of roughly 1,221,000 acres of forest land. Some 902,000 of these acres were directly lost to conversion of the land to something other than forest. However, this loss is partially offset by a gain of 548,000 acres where forests lacking ash were converted to types with ash.

On land that has been forest throughout the settlement period, the relative abundance of ash to other trees has gone up from 1.5 percent of forest land trees to 8.5 percent– nearly six times its historic abundance. These gains have occurred almost exclusively in habitats where ash is dominant. The acreage of ***monotypic*** ash forest has increased from 229,000 to about 406,000 acres. Why? Ash was excluded from habitats where fire was a chronic influence. Fire suppression has undoubtedly allowed ash to increase in Minnesota's western and southeastern forests. But this doesn't explain the shift to monotypic forest. More likely is the fact that swamps are not prime real estate or agricultural land. Uplands were developed leaving rich black ash, tamarack, and cedar swamps, undeveloped but not untouched.

Tamarack and cedar were heavily exploited during settlement for railroad ties and rot-resistant building materials – while ash was "good firewood."

In addition, Minnesota's tamarack population was devastated by European larch sawflies between 1900 and 1950.

Apparently, Minnesota's rich swamp forests with ash were left alone, and many with tamarack and cedar have succeeded to pure ash. In recent times, tamarack and cedar have shown little natural ability to regenerate in rich swamps.

GLOSSARY

monotypic: *Referring to conservation biology and successional changes leading to a single species.*

Chapter 2

Minnesota Ash Species Identification

Ash trees are difficult to describe and can be tough to identify. Out in the woods, ash trees do not have the flashy, distinctive white bark of birch trees, nor are they majestic giants that easily tower above the canopy like our stately white pine. However, ash does have its own distinction. They are one of the last tree species to leaf out in the springtime - and one of the first trees to drop its leaves in autumn.

Learning to identify Minnesota's ash trees will deepen your appreciation of our woods, and for a landowner, it's the first important step in learning how to care for your land. Take your time and practice throughout each of Minnesota's four seasons - and when all else fails ask your kids!

The classical Latin name for ash is *"Fraxinus"* meaning "spear." Ash are members of the Oleaceae, or the olive family. The flowers from the trees are pollinated from insects or through wind. Members of the ash family have the ability to reproduce through seeds, and vegetatively through stump sprouts.

There are about 65 species of ash trees, mainly found throughout the temperate regions of the Northern Hemisphere, but also ranging southward into the tropics. Minnesota forests are home to three of the 18 species found in the United States:

- **White ash**
- **Black ash**
- **Green ash**

Let's take a closer look:

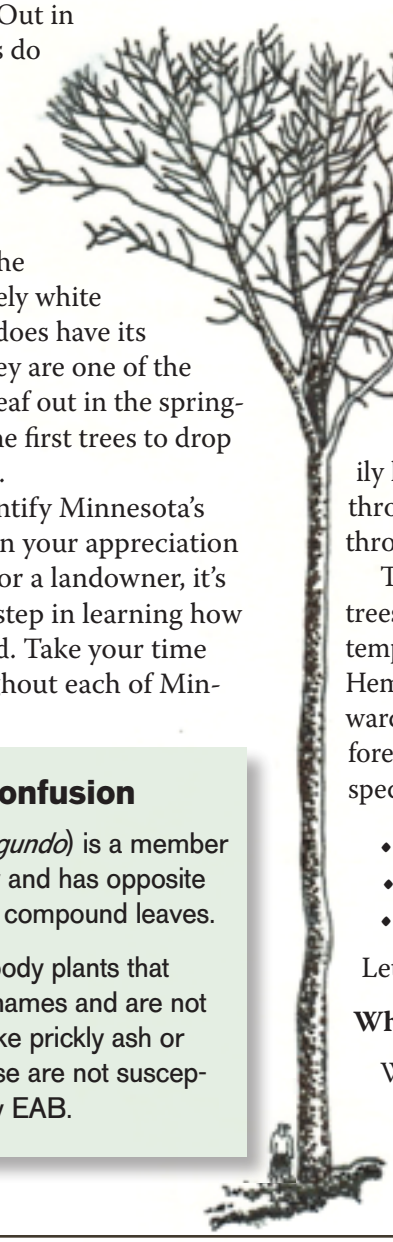
White ash- *Fraxinus americana*

White ash stands tall as a for-

Avoid Confusion

Boxelder (*Acer negundo*) is a member of the maple family and has opposite branching and 3-5 compound leaves.

There are other woody plants that have 'ash' in their names and are not true ash species, like prickly ash or mountain ash. These are not susceptible to an attack by EAB.



White Ash

est tree; its crown is relatively small. Compared to black and green ash, it is relatively uncommon, largely restricted to mesic deciduous forests in the southeast and east-central parts of the state.

You will usually find white ash in small groves, as scattered individuals, or mixed with northern red oak, basswood, or green or black ash. It is unlikely you will find white ash on active floodplains or in wet areas. It prefers fertile, loam soil on slopes along major streams.

Its seedlings like the deep shade of a mature forest, but will eventually die unless they obtain light from an opening in the canopy. The fruits of white ash mature by the beginning of September and are released during the autumn and winter. These are among the last trees to leaf out in the spring.

Black ash - ***Fraxinus nigra***

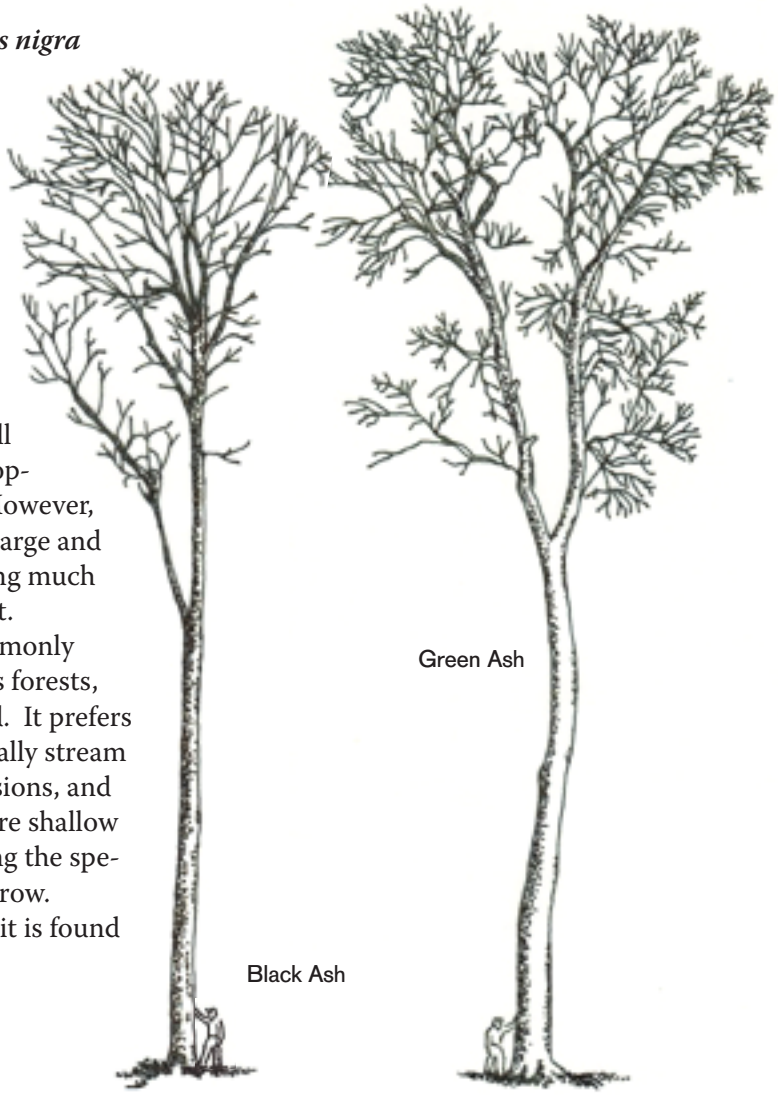
Like the white ash, black ash is tall and slender with a relatively small crown. Its bark has a silvery gray tone and, unlike the other ashes, its bark is fine textured, somewhat scaly, and not furrowed. Like all ashes, its leaves are opposite on the twig. However, black ash leaves are large and rather droopy, looking much like those of a walnut.

Black ash is commonly found in Minnesota's forests, especially northward. It prefers moist forests, especially stream banks, moist depressions, and swamps. The roots are shallow and spreading making the species prone to windthrow.

In upland areas, it is found intermixed with basswood, trembling aspen, white spruce, and maples. In these environments, it can grow quite large, sometimes exceeding 100 feet. In contrast, in wet, lowland habitats black ash is a stunted, small, and spindly tree, often no more than 30 feet high with only a few branches. Black ash seedlings are more tolerant of shade than green ash. Unlike white ash, it does not aggressively colonize open lands.

Black ash seeds are recognized as an important seed source for game birds, songbirds, and small animals, and is used as browse by white-tailed deer and moose. Flowers on black ash are generally formed by the end of May, with seeds appearing in late September. Some people think the fruit has a 'spicy' odor.

(Continued on page 13)



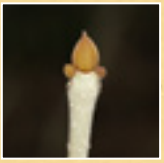
Simple identification features common to all ash:


MN DNR

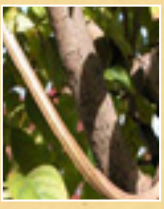
• Opposite Branching and Bud Arrangement: Branches and buds are located directly across from each other (opposite), not staggered (alternate). Note that sometimes buds, twigs and branches are lost from wind damage etc.


MN DNR

• Compound Leaves: Each leaf is composed of 5-11 leaflets, depending on the species. Leaflet margins may be smooth or toothed.


Julie Miedtke

• Winter Buds: Have large scales and look like deer hooves.


Ohio State Univ. Extension

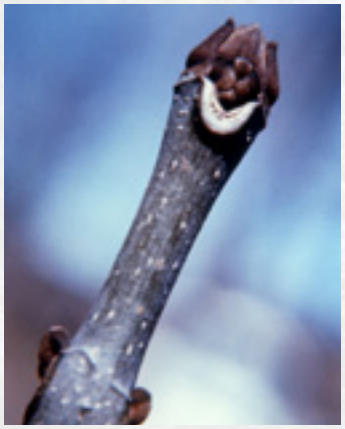
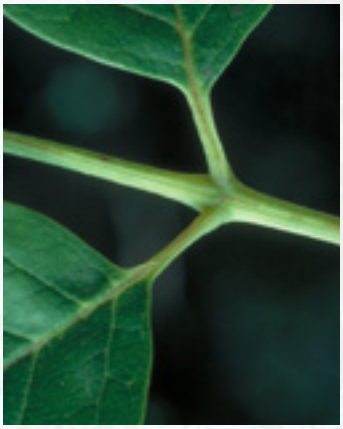
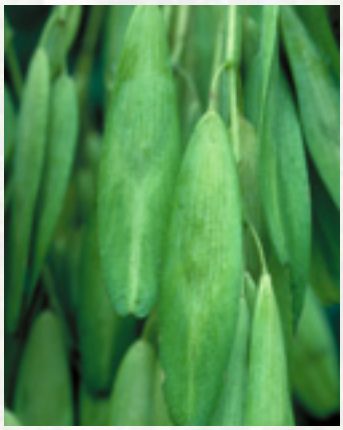
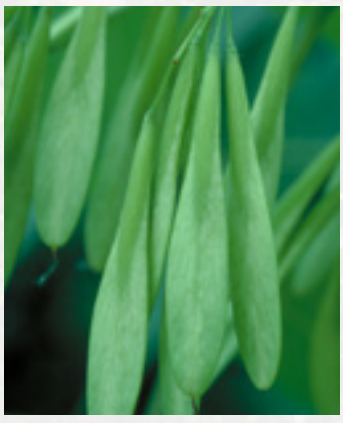
• Bark: Young ash trees have smooth bark. Older trees have different patterns, generally furrowed.


Ohio State Univ. Extension

• Seeds: Called "samaras", the seeds look like canoe paddles. They mature in the fall and can persist through winter.

How to tell an ash from an ash

Identifying characteristics

	Leaf Scar/Bud	Bark	Leaves	Fruits
White Ash				
	2-3 pairs of scales, rusty to dark brown. Terminal bud 1/5" long. Lateral buds are set within the leaf scar. Buds are paired with a leaf scar beneath the bud that looks like the letter "C" turned on its side.	Light gray-brown bark is characterized by having deep, narrow ridges that form a diamond shaped pattern.	8 to 12 inches long with 5 to 11 leaflets (usually 7); margin entire to partially serrate. Leaflets are stalked.	Light-brown samara, about 1" long; wing partially surrounding the seed.
	Julie Miedtke			
Black Ash				
	Buds are very dark brown in color. Generally, there is a space between the end bud and the nearest lateral buds.	Grayish in color and smooth when the tree is young, attaining some of the same furrows that can be seen in the bark of both green and white, but usually not as deep.	10 to 16 inches long with 7 to 11 leaflets; margin finely serrate; leaflets have no petiole.	Samara are broad to oblong, usually 1 to 1½ inches long, blunt at the base.
	Ohio State University Extension			
Green Ash				
	Bark rusty brown, woolly, set above leaf scar. Leaf scars nearly straight across the top. Buds are paired with a leaf scar beneath the bud that looks like a sideways "D" (like a smile).	Very similar to that of white ash but not quit as deeply furrowed.	6 to 10 inches in length with 7 to 9 leaflets; margin serrate along entire length of leaflet.	Samara typically 1¼ to 2¼ inches long and ¼ inch or less in width. The wing of this samara is more pointed than that of white ash.

All photos from MN DNR-Welby Smith, unless indicated otherwise

Green ash - ***Fraxinus pennsylvanica***

Green ash is one of the most common of the ashes, particularly in the southern part of the state. Unlike black ash, green ash does not grow in swamps; however, you will find black and green ash growing side by side on upland sites. You will find green ash in basic (***calcareous*** sites) or soils that are slightly acidic. You will find green ash in sand, silt, clay, or loam soils, but not in ***peat***. Young trees grow rapidly and will resprout if they are damaged or cut. They produce large numbers of seeds and are vigorous colonizers of abandoned agricultural and urban lands. Green ash seedlings do not survive under deep shade.

Photo: DNR/Tom Klein

A mesic ash stand

GLOSSARY

calcareous: *An adjective used in a wide variety of scientific disciplines, referring to the deposit of calcium carbonate or lime. In some cases it may refer to a layer of sediment or sedimentary rock, a limestone deposit. Calcareous soils are relatively alkaline, in other words they have a high pH. This is because of the very weak acidity of carbonic acid. Note that this is not the only reason for a high soil pH.*

peat/peatlands*: Organic soil material that originates from plants.*

Ash: A 21st Century Resource

Minnesota's ash trees are abundant in our rural and wildland areas, typically supplying between 30,000 and 40,000 cords of wood each year, mainly for pulp and paper, but also for firewood and specialty products such as cabinets, furniture, and veneer.

Let's wander through the aisles of a variety of ash products:

Economic significance and uses of wood

Working Properties

Black and green ash have lower specific gravities and lower strength properties than white ash, but they are still moderately strong, hard, and stiff compared to other Minnesota native hardwoods. They also split easier, shrink more, and are average in workability and gluing.

Photo: U of M Extension/David Wilsey

When an ash log is pounded, the growth rings come off in thin layers, providing the material needed for basket making.

Opposite page: Green ash lumber showing emerald ash borer defect.

Photo by James Solomon, USDA Forest Service, Bugwood.org

Photo: Christopher Cotrell

Ash wood has been gathered and shaped into snowshoes of varied design by many cultures that inhabit the boreal and sub-boreal forest ecosystems. Ash wood lends itself to manipulation and retains its given form once dry. Ash is also lightweight, making it ideal for snowshoes, toboggans, and vessels. The wood properties of ash have made them a fiber source for a few Minnesota-made products:

Pulp and Paper: Two of Minnesota's pulp and paper mills use small amounts of ash mixed with other species to create paper pulp. These mills used about 10,000 cords of ash in 2007.

Engineered Wood: Ash is used by one Minnesota mill to manufacture hardboard.

Solid Wood Products: Over 100 Minnesota sawmills use some ash, but the overall consumption is low. Total ash use in 2007 was about 9,000 cords. There are several exporters for black ash veneer. The volumes are small but these exports are high value.

Minnesota's ash paneling industry is viable, particularly when it comes to black ash. Black ash is sawn into paneling and flooring when quantities are available (and that may not be regular or often). Ash has always been an offering in the paneling and flooring industry. Black ash is also used as a craft wood both in niche market items and traditional Minnesota-crafted items such as snowshoes and baskets. Also, ash is popular for firewood as it is easy to split.

While the industry that produces paneling and pallets is big, their use of ash isn't. There are a couple reasons for this. The size and quality of the raw ash material is undependable. Not very much ash makes it to sawlog or veneer size. The supply just doesn't lead to a consistent demand.

Another reason is that harvesting opportunities are limited to the season when the ground is frozen or dry, because ash is most often found in lowland areas. Those in the timber industry tend to focus their efforts in the winter season on species they are certain they can market.

While a number of factors make harvesting ash undesirable, other characteristics make Minnesota ash desirable for various industries. Ash has a unique, variable grain pattern that appeals to many.

It is not a "light-colored" wood, but it is not a "dark" wood either. It is somewhat vulnerable to fashion swings. If light-colored paneling is "in" to make the ceilings look higher and the room look

Photo: Dailyinvention

Ash trees are common 'urban trees,' lining the streets and boulevards of communities throughout Minnesota. And, as with most urban tress, ash trees bestow beauty, cut energy costs, and absorb and filter storm water – services estimated to be worth over $290 million each year to Minnesota communities.

Most often, discussion centers on the large proportion of ash trees that comprise urban and suburban landscapes. Ash species were used to replace elm trees after Dutch elm disease wiped out what was once the predominant urban landscaping tree. Ash trees sometimes comprise one quarter or more of the trees in municipal areas.

Photo: John Zasada

bigger, then ash is not the first choice. But it has enough character that it can sway the opinion when it comes to choosing.

It has the "bend" that craftsmen like (e.g. in making snowshoes); the growth rings come off in thin layers when a log is pounded, thus providing the material for basket making; and the wood color and unique grain pattern provide value and uniqueness in the creation of specialty items (e.g. ash bowls).

Page 18: A white ash strip pack basket constructed by Mike Benedict; Inset: Black ash woven bowls crafted by Dennis Chilcote

What about dead/dying black ash, after invasion of Emerald Ash Borer?

Firewood will be a primary market for dead ash

In many stands of ash the tree trunks are small in diameter, which makes them appealing to markets that use fiber rather than needing larger logs to create a solid wood product. The ***BTU*** value of ash makes it a desirable firewood source, particularly in rural Minnesota. Another attribute of ash for the home heating crowd, is the fact that it splits very easily, thus making it a preferred choice over other species of wood.

Marketing experts expect that the sheer volume of smaller diameter ash, as well as the size and location of naturally occurring ash stands will drive utilization in the direction of firewood.

Because of ash's splitting characteristics, homeowners are more apt to purchase truckload quantities in 100" or tree length and do their own processing into firewood. Loggers will achieve a better production rate with this type of processing. They will not have to apply extra effort during logging and delivery, so will be more likely to harvest ash stands. *Moving firewood is not recommended. See pages 21 and 25 for details.*

It is important to note that there are markets for medium and larger ash logs as saw material and veneer logs. Sorting of larger material to higher value uses will result in greater economic returns.

GLOSSARY

BTU: *British Thermal Unit, is a basic measure of thermal (heat) energy. One BTU is the amount of energy needed to heat one pound of water one degree Fahrenheit.*

Survey Recommendations: Wood Markets

Firewood and biomass will be the main market for dead ash. Ash prices will decrease. Several experts pointed out that the transportation distance to markets and local quarantines will play a major role in future ash markets. It was also pointed out that high value ash markets will be impacted by decay fungi as ash die. Landowners should harvest ash when considering an already scheduled harvest. Landowners should assess their ash inventory and plan a replacement strategy now. One entomologist summarized several recurring comments this way: "I think landowners in the entire state should get the recommendation to consider management to reduce the amount of ash if they have a lot and they should not delay. But they also don't need to panic. As the land gets closer to known EAB infestations the urgency increases. But I am not so sure the management recommendations would change much- reduce ash- don't eliminate ash. Management recommendations in and around communities may be different but that will depend on the situation and how the community is dealing with EAB." The expert panelists recommend: **Do not liquidate ash immediately.** Efforts to leave some ash for genetic stock are more likely to survive if neighboring threats are reduced." Reduce ash populations in their stands to reduce EAB impacts.

Photo: Julie Miedtke

Ash logs destined for baseball bat production.

Photo by Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, Bugwood.org

Information on Quarantines

When ash has been killed by EAB, county-by-county quarantines will be put into effect by the Minnesota Department of Agriculture. A ***quarantine*** is a temporary rule intended to help prevent a potentially dangerous or destructive pest or disease organism from spreading outside a known infested area into new areas. In the case of EAB, the quarantine is designed to limit the movement of potentially infested firewood or other materials such as live ash trees that might harbor EAB larvae.

The regulations for transporting wood out of a quarantined county will require actions that will add cost to the raw wood material harvested from the forest. For many wood products, this extra processing will be cost prohibitive. The least expensive action to enable ash to be transported out of a quarantine county will involve chipping the solid wood in order to destroy the medium that EAB uses to reproduce.

Chipping will add the least cost to harvested ash wood as markets will readily accept chips. Markets for chips in Minnesota include ***biomass*** burning facilities, located in both rural and urban settings, a few pulp mills, and one ***oriented strand board*** mill. By far, the market for fuel chips will absorb most of the volume produced by this method.

Ash prices will decrease

It is possible that large volumes of ash will be killed at the same time, necessitating the removal of more volume than could be absorbed by current markets. The effect of an oversupply of any commodity is that the unit price of that commodity drops. This situation could easily happen with ash.

It is likely that this condition would be short-lived and last until the volume of dead ash is reduced. At that point, it seems probable that, because of a scarce supply, the price of ash would begin to recover to former levels, perhaps even increasing to a premium level. Ash has never garnered a very high price in the wood stumpage market. The affect of quarantines on the movement of ash resources will potentially be major.

Specialty markets significance

Burls are abnormal growths that provide a wonderful source for decorative wood with fanciful grain or figuring. It is believed that a burl is created when there is an injury or other external stimulus that affects the growth pattern of the tree and results in a deformity. Wood grain patterns may be wavy, swirled, marbled or feathered depending on the type of burl.

Ash is considered one of the best of these "***character woods***;" burls on ash trees are highly sought after. Ash displays a pronounced grain, with a wide to broad range of grains and color that make it uniquely the most consistent choice for those looking for character wood or real "wood" feel. Ash takes stain extremely well and its grain

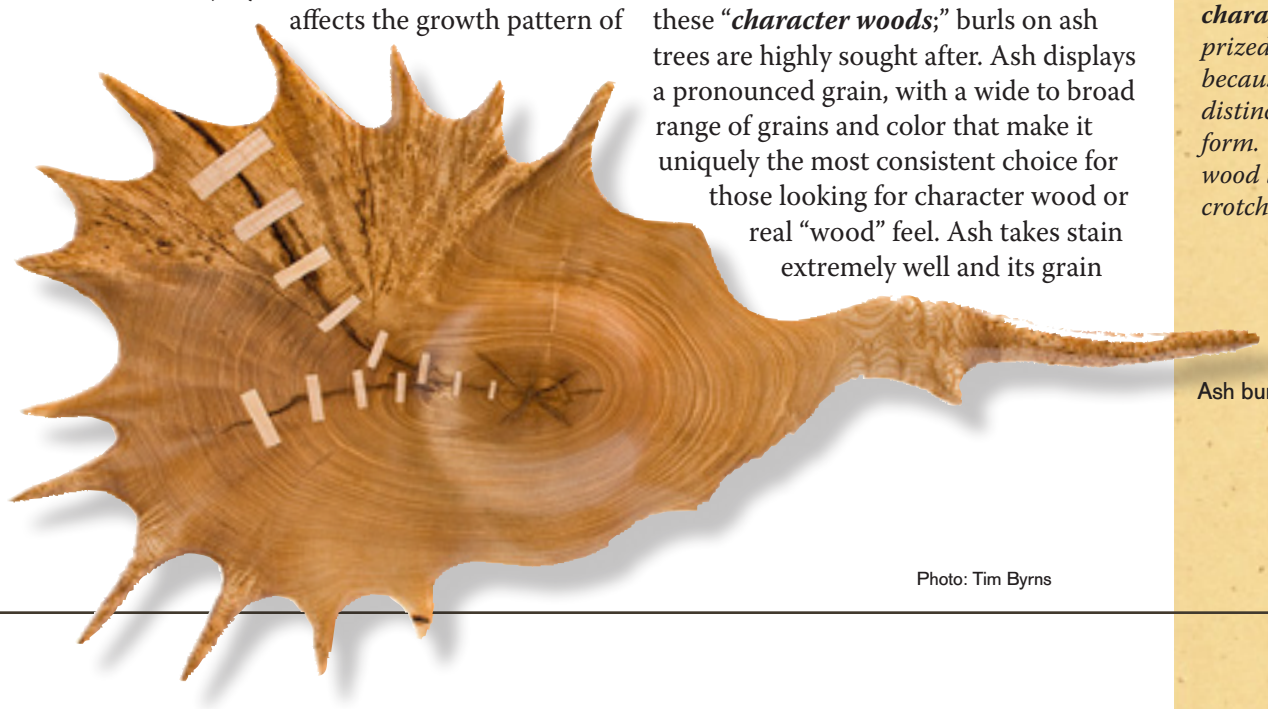


Photo: Tim Byrns

Ash burl, "Fraxinus cornu"

GLOSSARY

quarantine: *A temporary rule intended to help prevent a potentially dangerous or destructive pest or disease organism from spreading outside a known infested area. In the case of the emerald ash borer (EAB), quarantines are designed to limit the movement of potentially infested firewood or other materials such as live ash trees that might harbor EAB larvae. For more information on quarantines see Appendix B, pages 63-64.*

biomass: *Harvesting the wood product obtained (usually) from in-woods chipping of all or some portion of trees including limbs, tops, and unmerchantable stems, usually for energy production.*

oriented strand board: *Also known as OSB or waferboard, is an engineered wood product formed by layering strands (flakes) of wood in specific orientations.*

burl: *An abnormal growth of woody tissue protruding outward from a tree stem or trunk.*

character wood*: Wood prized by artists or craftsman because of its unique or distinctive grain patterns or form. Examples of character wood include burls and crotch wood.*

characteristics allow it to highlight a beauty only nature can provide.

Although the quality of burl is not known until you begin working with it, burl wood can be used for veneer or frequently turned to create high end products like clocks, mirrors, knife handles, wood bowls etc.

Cultural significance

The unique characteristics of black ash have made it a staple of the traditional American Indian basket-making industry. U.S. Bureau of Indian Affairs forester and basket maker Michael Benedict predicts: "If and when emerald ash borer gets to the state's remaining stands, the material will be very rare or nonexistent in some areas."

Ash holds cultural significance to certain communities. Many woodland communities prize ash for its characteristics and feature ash wood in practical tools, many of which have become elevated to art forms. Black ash, in particular, is prized in basketry because of the straight and smooth trunks. Once it has been felled, the tree ***bole***, or trunk, is pounded to remove the sapwood layers.

Pounding the tree separates the growth rings into strips about the thickness of a nickel. Pounded strips are soaked, cleaned, and separated again into thinner strips. Depending on the thickness of the original strip, this process can occur several times, each yielding thinner and finer "ribbons" of wood.

Larger strips are used to form the basket's base and sides. Thinner strips, or weavers, are used to weave the basket's bottom and sides. Black ash baskets have a rich tradition. Ash baskets make excellent pack baskets and were likely used to transport goods by the voyageurs. Ash baskets bring high prices in the marketplace: large baskets can cost thousands of dollars. Basketry is not a quaint relic of the past. Today, people use this early technology to create and sustain forest-based enterprises.

GLOSSARY

bole: *The trunk or main stem of a tree.*

Photo: U of M Extension/David Wilsey

A hand-woven, black ash basket taking shape

For further information on Cultural Signifcances of Ash, see Appendix D, page 66

The Emerald Ash Borer

A little package carrying big trouble

Emerald ash borer (EAB) is a non-native insect that kills ash trees; it was found in St. Paul and near Houston County, Minnesota in 2009. EAB is the focus of efforts to guide management of ash stands on public and private forested lands. The discovery of this invasive insect in Minnesota is one of the main reasons this Guide was developed.

Life cycle

Emerald ash borer starts out as a flat, rust-colored egg, just a smidge bigger than the period at the end of this sentence. A single female will lay 80 eggs or so on the bark of ash trees in summer.

A lanky white larva emerges, burrows into the bark, and begins eating tissues between the sapwood and bark. In the process, it cuts off the conduits that carry nutrients from roots to leaves and sun made sugars from leaves to the rest of the tree. It will feed and grow all summer.

The next spring the larva morphs into a pupa. In early summer the pupa develops into an adult beetle. Two or three weeks later, the beetle bores out of the bark, leaving a telltale D-shaped escape hole. Preparing to overwinter, a larvae chews a shallow hole in the sapwood (< ½ inch deep). Newly emerged adults

Photo: Jeff Hahn

Adult EAB (actual size ⅓ - ½ inch)

Emerald ash borer shown in ash tree; size compared with a man's finger.

Serpentine larval galleries exposed by woodpecker activity.

Actual EAB larvae inside ash tree.

Thinning foliage in crown of ash tree.

"D" shaped exit hole of EAB shown on bark of white ash.

Background Photo: Jeff Hahn
Inset Photos: Mark Abrahamson

feed on ash leaves for a few weeks before mating and starting the cycle again.

Infestations can be recognized by dead and dying trees that have ***serpentine galleries*** on the surface of the sapwood of branches and stems, D-shaped exit holes in the bark and signs of woodpecker attack such as stripped bark on branches and stems. Eventually twigs, branches, and ultimately the whole tree dies.

Adult females can re-infest the tree or fly to a new location. Natural spread may occur up to four miles per year. An infested ash stand can be 96% dead in six years.

What you need to know

EAB kills ash trees and it does so in great numbers. Already it has killed millions of ash trees in North America. EAB will have a huge effect on Minnesota's landscape and the 937 million ash trees that grow in our cities and forests.

- You can expect EAB to spread throughout Minnesota, eventually; it may take decades.
- EAB kills all species of ash trees in Minnesota: black, green, and white.
- EAB kills 99% of North American ash trees.
- There are some trees with resistance to EAB located in China.
- Cold temperatures in Minnesota may slow EAB down, but will not eliminate them.

Photo: DNR

Heavy woodpecker activity on a tree is often a sign of EAB infestation.

- Planning ahead and managing ash before EAB arrive will give you more time and will help keep your land forested.
- Natural enemies of EAB exist in China; some of these insects are being released in Minnesota to help slow the spread of EAB.
- Recognize the signs and symptoms of an EAB infested tree: heavy woodpecker activity on tree, dying branches in the top canopy, ***sprouts*** around the tree base, vertical cracks in the bark, S-shaped tunnels under the bark, and ⅛ inch D-shaped exit holes in the bark.
- If you have ash trees on your property, now is the time to plan for a future with fewer ash trees.

GLOSSARY

serpentine galleries: *Trails that wind and twist, like a snake.*

sprouts: *Shoots arising from the base or sides of a woody plant.*

Do NOT transport firewood!

Do not transport firewood, even within Minnesota. A major culprit in spreading EAB and other insect pests is firewood. Larvae and pupae can hide beneath the bark and then escape as adult beetles after being transported many miles. Look at the map on page 28 of where EAB has been found. How did it hop from one state to another? Many of the places where it was found are parks and campgrounds. People carried EAB with them when they brought firewood on a picnic or camping trip.

What About the Cold?

Scientists are still studying EAB's winter survival in northern Minnesota. People with significant amounts of ash should not dismiss the threat of EAB, regardless of where their stand is located. However, data from 2009-2010 field season shows evidence that winter survival of EAB is poorer in northern areas, and

Survey Recommendations about EAB cold hardiness

More research is needed on the hardiness of EAB; however there is enough uncertainty that landowners should know EAB may spread more slowly in northern MN. Based on preliminary research, EAB survival in northern Minnesota will be lower than in southern Minnesota and will likely reduce population buildup and spread of EAB. One genetics expert pointed out, "There is evidence to suggest that winter survival of EAB in northern MN could be expected to be lower than in southern MN. That says nothing about how lower survival rates may impact spread of the adults." "Natural spread is not the primary (or sole) issue of concern." Also according to a silviculturalist, "It's always true that bugs reproduce less in colder areas, but EAB lives in some areas in China that are much colder than MN (even northern MN), and some fairly mild areas. However, the bug might be able to undergo selection for cold tolerance in several generations, and climate change might also come into play."

Ash management recommendations should be based on the distance to a known EAB infestation. One word of caution from a harvesting expert is "please consider proximity to major roads of people moving in from EAB occupied zones. And hardiness information as it becomes more available from places like Michigan." One entomologist also pointed out that shifting climate patterns may alter EAB spread for various locations throughout the state. If management zones are desired, create them based on proximity to known EAB locations and likely next occurrences. Thoughts from another entomologist are, "the distance to a known EAB infestation and hardiness zone information right now should only affect the urgency for doing something, not the types of management recommendations. Hardiness of EAB in northern Minnesota should only influence the urgency of doing something not what is actually done."

In addition to hardiness, research about EAB and black ash may also affect future management recommendations. An important point to remember that is because EAB is a relatively new exotic pest our knowledge of the insect and our management or control recommendations will change over time, and sometimes this may change quite rapidly." Another comment from an entomologist, "I am also somewhat reluctant because we were told that Dutch elm disease wouldn't be a problem in northern Minnesota and that gypsy moth would not be as much of a problem in northern Minnesota as in southern Minnesota. Insects and diseases have a way of surprising us." Another recommendation from the panel of experts is that ash management recommendations should be based on both distance from a known EAB infestation AND hardiness zone information.

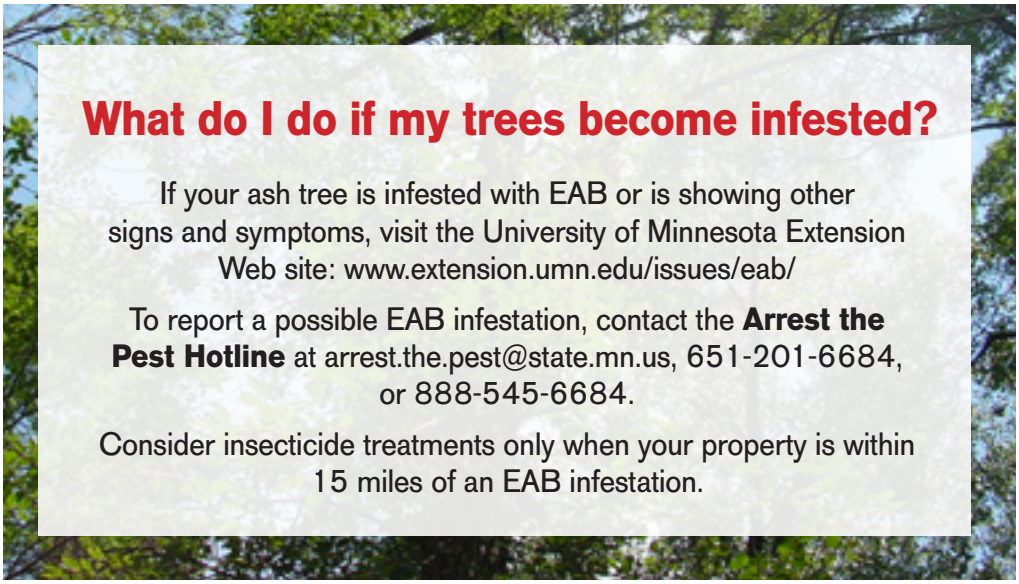
will likely reduce population build-up and the spread of EAB.

It is also VERY important that landowners stay abreast of this research as the results may have drastic impacts on ash management in northern Minnesota.

Landowners should consider both the distance their land is from a known EAB infestation, likely EAB introduction sites (possibly along roads), as well as information from the newest research in EAB cold tolerance.

Photo: clgregor

Preliminary data suggests that EAB survival may be lower in northern Minnesota than in southern Minnesota because of extremes in low temperatures in the north.



What do I do if my trees become infested?

If your ash tree is infested with EAB or is showing other signs and symptoms, visit the University of Minnesota Extension Web site: www.extension.umn.edu/issues/eab/

To report a possible EAB infestation, contact the **Arrest the Pest Hotline** at arrest.the.pest@state.mn.us, 651-201-6684, or 888-545-6684.

Consider insecticide treatments only when your property is within 15 miles of an EAB infestation.

GLOSSARY

phloem: *A layer of cells just inside the bark of plants that conducts food from the leaves to the stem and roots.*

Manage ash trees to keep EAB populations low

Emerald ash borer is considered a ***phloem***-feeding insect. Phloem tissue is basically the inner bark in trees. A single large tree will have much more phloem tissue than a small tree simply because of its greater bark surface area. We can estimate how much phloem tissue is available on any given acre by counting the number of ash trees and their size.

The amount of phloem available will dictate how many emerald ash borer offspring could be produced in any given area. The concept is actually quite simple, the more food that is available for emerald ash borer larvae, the greater the number of offspring that can be produced.

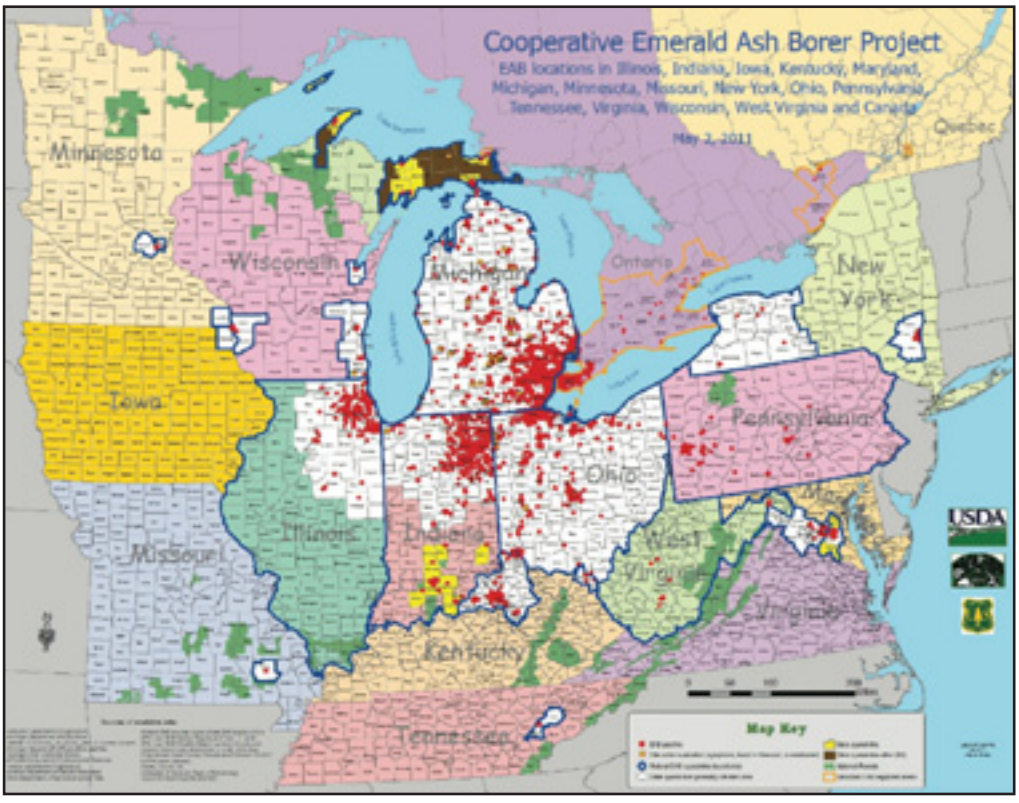
Ash phloem reduction is an attempt to reduce the amount of food available to EAB. A lack of food could limit how quickly an EAB population expands.

Phloem reduction is generally recommended near locations where EAB is newly introduced and would generally be considered an EAB management strategy not necessarily an ash management strategy. Many stands in the wet forest and floodplain forest types have large amounts of ash and therefore large amounts of ash phloem. This makes them highly vulnerable to EAB once the insect does arrive in the area.

Therefore, some professionals suggest that forest management in these areas might include some level of ash removal and replacement with other site appropriate species as a stand management tactic that could also accomplish long term phloem reduction on those sites.

Survey Recommendation

Ash phloem reduction strategy is meant for EAB management not ash management, but it could be considered when managing these stands as one of many considerations.



Emerald ash borer locations in Midwest and eastern states.

Key:
Red dots = positive for EAB
Blue outlines = federal quarantine area

The Native Plant Communities

The Minnesota Department of Natural Resources and the U.S. Forest Service have developed a system of classifying areas of land that display similar ecological features. The system helps land managers and researchers identify, describe, and map a unit of land that has uniform ecological features.

The system uses associations of ***biotic*** and environmental factors, for instance: climate, geology, topography, soils, ***hydrology***, and vegetation to come up with ecological patterns for areas as large as North America or as small as a single timber stand.

Following are descriptions of the five systems in which ash in Minnesota will occur. A more common term for these ecological systems is '***native plant community***.' We will use the term "native plant community" in this guide, instead of ecological classification system. Read on for a more in-depth description of a native plant community.

What is a native plant community?

The purpose of this classification is to help land managers make decisions and understand how native ecosystems function. Nearly all land management activities affect vegetation and the native vegetation provides important clues as to the potential that land has to provide timber, wildlife habitat, and recreational opportunities. Equally important, the Native Plant Community (NPC) classification tells land managers about critical habitats that Minnesota's rarest plants

Identifying Your Native Plant Community

There are many kinds of vegetated areas that are not native plant communities. These include places where native species have largely been replaced by exotic or invasive species such as smooth brome grass, buckthorn, and purple loosestrife. Also, planted areas such as orchards, pine plantations, golf courses, and lawns are not native plant communities.

Areas not considered to be native plant communities include areas where modern human activities such as farming, overgrazing, non-sustainable logging, and development have destroyed or greatly altered the vegetation.

Photo by Muffet

GLOSSARY

biotic: *Pertaining to living organisms and their ecological and physiological relations.*

hydrology*: The study of the movement, distribution, and quality of water on Earth and other planets, including the hydrologic cycle, water resources and environmental watershed sustainability.*

native plant community*: A native plant community is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes that tend to repeat over space and time. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes.*

and animals need to survive into the future. In this Guide, the NPC classification is used as a framework for organizing thoughts and facts that concern the ash resource. The classification is used to help landowners understand why ash trees grow where they do and to provide guidance on management strategies.

For some Systems, there is much to do; for others, there is little that we can do.

So, what is a native plant community? A native plant community is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units. For instance, if you were walking through a woodland, you might immediately identify that you were walking through an oak savanna, a pine forest, or maybe sloshing through a marsh.

Native plant communities are named for the characteristic plant species or for a characteristic environmental feature contained within them. Examples of native plant communities in Minnesota include Dry Barrens Oak Savanna, Red Pine-White Pine Forest, Bulrush Marsh, Sedge Meadow, and ***Mesic*** Sandstone Cliff. For purposes of this Guide, you should know that ash will potentially be found in one of five native plant communities or systems.

Two systems: Forest Rich Peatlands and Fire Dependent typically contain minimal ash, but were included in the survey so are included here. The five systems, or native plant communities, are:

- **Wet Forest System**
- **Floodplain System**
- **Mesic Hardwood System**
- **Forested Rich Peatland System**
- **Fire Dependent System**

Hydrology and Minnesota Native Plant Communities

Soil moisture in forest soils is defined by conditions during the summer growing season. The order from dry to wet in forests dominated by ash or with a significant component of ash is: Fire-Dependent, Mesic Hardwood, Floodplain Forests, Wet Forests, and Forested Peatlands. Flooplain Forests are, of course, flooded during the spring runoff period and occasionally during other times; however, in most years during the summer months, soils are less wet than summer soils in the Wet Forest system where mucks, peats, clays, and high water tables maintain wet-mesic to wet soil moisture regimes. Floodplain Forest soils tend to dry some as the water level in the river drops from flood stage (bankfull) to summer, low flow conditions. The average position of the growing season water table below the soil surface also determines the tree species and herbaceous species associated with ash. Forested peatlands are wet year round because of restricted outflow from the peat basin. Peatlands with the highest peatland slopes have the tallest trees because the down slope movement of water is quickened and the peat soil is thus better aerated during the summer growing season.

Photo: MN DNR

Page 30: Floodplain Forest System, Somerset Wildlife Management Area

Photo: Brian Lockhart, USDA Forest Service, Bugwood.org

GLOSSARY

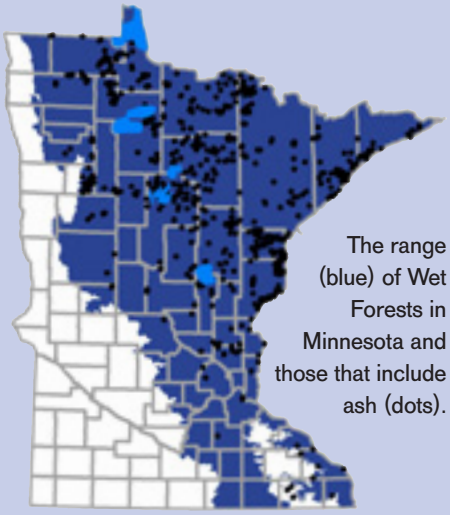
Mesic: *Sites or habitats characterized by intermediate moisture conditions.*

Green ash leaflet, showing the compound leaf

Ash in the Wet Forest System

GLOSSARY

pure stands: *Forest, crop, or stand composed principally of one species, conventionally at least 80 percent based on numbers, basal areas, or volume.*



The range (blue) of Wet Forests in Minnesota and those that include ash (dots).

Wet Forest (WF) communities occur commonly in narrow zones along the margins of lakes, rivers, and peatlands; they also occur in shallow depressions or other settings where the water table is within reach of plant roots. The supplies of groundwater and runoff typically are at their peak early in the spring and then diminish throughout the growing season. The contribution of runoff to these systems is greatest in northeastern Minnesota; it lessens in the southwest to the point where wet forests there are fed entirely by upwelling groundwater. Black ash acts like a hydrologic pump, lowering the water table as summer progresses. *The seasonal variability in soil moisture is a hallmark of the WF System.* This variability controls the availability of the oxygen.
This oxygen is essential for:

- roots to respire;
- decomposition of organic litter; and
- release of nutrients in forms that are usable by plants.

This physical environment is problematic for most of Minnesota's trees, except for ash and northern white cedar. Consequently, it is specifically these two species: ash and white cedar, that tend to dominate WF sites. Oftentimes, they are found as ***pure stands*** of those species. All plant communities designated as "WF" sites have some ash regeneration, and over 75% have ash trees in the canopy. Black ash is the WF specialist, occurring in 69% of all wet forests, and the average stand is 36% black ash trees.

Common Trees:

- Black ash
- Northern white cedar
- Green ash
- Balsam fir

Photo: Paul Wray/Iowa State University, Bugwood.org

Red-osier dogwood is an indicator of the Wet Forest System.

- American elm
- Red maple

Understory species:

- Rough alder
- Mountain maple
- Beaked hazelnut
- Red-osier dogwood
- Swamp red current
- Red raspberry

Green ash occurs in 9% of wet forests and comprises 11% of the trees when present. White ash does not occur in wet forests. In addition to ash and cedar, wet forests are usually mixed (83%) with some other trees. Balsam fir, American elm, and red maple are the most important species to also occur in wet forests.

The ground in wet forests is covered with a luxurious growth of herbaceous plants that is usually dominated by either ferns or grass-like plants.

Herbaceous plants:

- Lady fern
- Oak fern
- Shield fern
- Crested fern
- Woodland horsetail

Grasses & Sedges:

- Bluejoint grass
- Graceful sedge
- Bristle-stalked sedge
- Bladder sedge
- Long-stalked sedge
- Awl-fruited sedge

Wildflowers:

There are two distinct seasons for wildflowers in wet forests – spring and fall.

In the spring, plants adapted to waterlogged soils thrive. Most noticeable are the yellow cowslips that define the extent of wet forests on the landscape and lend the first blush of color to a brown world recovering from winter. Annual plants that have waited all season

Photo: J.C. Lucier

Lady fern

for the soils to dry can dominate the fall wet forest. The most common are:

- Jewel weed
- Beggar's ticks
- Dwarf raspberry
- Naked miterwort
- Alpine enchanter's nightshade
- Sweet-scented bedstraw
- Common strawberry
- Canada mayflower
- Bunchberry
- Water horehound
- Goldthread
- Red-stemmed aster

Wet forests are Minnesota's most diverse kind of forest. On average, 50 different species of plants can be found in an area the size of an urban back yard; it is not uncommon to find more than 100 species. There are three reasons for this diversity. First, wet forests are often linear inclusions in uplands and some terrestrial plants find refuge in the driest habitats available in wet forests, but many wet forest plants can't tolerate upland conditions. Second, wet logs, pools of water,

Photo: Juile Miedtke

Wet Forest

raised tree bases, moss clumps, and tip-up mounds provide a great diversity of plant habitat at a fine scale. Third, as mentioned before, wet forests undergo a major change in plant habitat throughout the season from waterlogged in the spring to rather dry in the fall. Some rare plants and animals are dependent upon wet forest habitat in Minnesota. Be wary of invasive plants and weeds in wet forest sites.

Hydrology in Wet Forest Systems

Wet Forest and Forested Peatland systems have shallow wet soils with limited water flow rates in the upper soil horizons. In these forest systems, two primary goals of any forest harvest are (1) protection of the limited soil pore space and water flow rate that exists and (2) perpetuation of the forest canopy so that maximum evapotranspiration occurs on these sites. Rutting on these sites further diminishes water flow, keeps soils colder into the growing season, and brings the water table closer to the surface. It is not unusual for badly rutted sites in these systems to become dominated by grasses, sedges, and cattail with the exclusion of trees. Forest harvest should target perpetuation of late-succession forest canopies in the 80 to 100% range and should be done only on frozen or dry soils. It should be noted, that deep snow packs over unfrozen soils will not prevent soil compaction and rutting.

Wet Forest: Dieback and decline

Emerald Ash Borer or Dieback-which is it?

Many hardwood tree species have experienced periods of branch ***dieback***, often called "decline." Symptoms include slow growth, thin crowns, and misshapen or discolored leaves. Characteristic of these decline episodes is that one single 'cause' of the decline cannot easily be identified. Instead, evidence suggests that trees have been stressed and were then invaded by one or more organisms that are not normally damaging to those trees. Biotic agents such as defoliating insects or ***abiotic*** factors such as severe drought can predispose trees to a number of pathogenic organisms that further damage trees. However, not all affected trees will die. Once the stress is removed, many trees are able to regain normal vigor and growth.

Dieback of black ash is an example of a condition affecting trees in many areas of the Lake States and especially in northeast and north central Minnesota. For years, dieback, thin crowns, and in some stands – tree mortality have been observed. Adding to the appearance that this species is in decline is that black ash has a late ***leaf flush*** and early leaf fall, therefore the trees seemingly never have full, vigorous crowns.

In recent studies, it has been found that the most seriously affected trees were nearest to roads and on the wettest sites; even then, tree mortality was relatively low. No causal agent was found affecting trees with dieback, and on many trees crown recovery (multiple years of new branch growth) was occurring.

Distinguishing between the symptoms of decline or ***crown dieback*** *and EAB is extremely difficult and critical.* Landowners, especially those in the northern Wet Forest (WF) systems are encouraged to work with professional foresters to diagnosis, monitor, and carefully manage these sites.

Epicormic branching: Erratic growth from ***adventitious*** buds sprouting on trunks of trees may indicate dieback. It's a coin toss as to whether the tree is recovering and beginning to rebuild its crown or dying. ***Epicormic branching*** may also be a symptom of a tree infested with emerald ash borer.

Photo: Juile Miedtke

Ash dieback in northern Minnesota

GLOSSARY

dieback/decline: *The progressive dying from the extremity of any part of a tree.*

abiotic: *Nonliving parts of an ecosystem, such as soil particles, bedrock, air, and water.*

leaf flush: *The time in the season during which leaves appear on a tree.*

crown dieback: *Decline of the branches and limbs in the canopy of a tree sometimes used as an indicator of tree health.*

adventitious: *Pertaining to a plant part that develops outside the usual order of time, position, or tissue — e.g., an adventitious bud arises from any part of a stem, leaf, or root but lacks vascular connection with the pith; an adventitious root arises from parts of the plant other than a preexisting root, e.g., from a stem or leaf.*

epicormic branching: *A shoot arising spontaneously from an adventitious or dormant bud on the stem or branch of a woody plant often following exposure to increased light levels or fire.*

Survey Recommendations: Wet Forest

- If site does not have natural drainage, tree loss is likely to increase water table depth.
- Fire danger will increase when ash sites are replaced with grasses or cattails especially if the late summer or autumn is dry; fire intensity will increase.

Harvesting Wet Forest sites is very sensitive and extreme care should be taken when considering such an activity. Harvest when ground is frozen or dry. Clearcutting is not recommended. However several experts commented that strip or patch cuts may be appropriate especially when dealing with stands mixed with conifers.

Use harvesting methods appropriate to allow for desired regeneration. Consider ash phloem reduction thinnings in conjunction with a sound regeneration plan and when EAB is known within 15 miles of a site. According to one silviculture expert, "Use what works. You still have to deal with high water tables, EAB or not." Expect increasing water tables after ash has died or is harvested.

Because of the degree of uncertainty, new silvicultural practices need to be explored for Wet Forest stands because of EAB. According to one expert panelist in Ecosystem Classification System, "The concern is greatest in Wet Forests where black ash is dominant. The collapse of a local, dominant population will leave considerable niche-space open for other plants. Unfortunately, this will not always be trees. Only white cedar is similarly adapted to wet forest sites and regeneration of cedar has been nearly non-existent due to deer depredation and adequate safe sites for seedling germination and survival. In all other systems, there are other trees that can fill the niche void when ash die."

Regeneration strategies could include both natural colonization and planting. It was noted that regeneration in these stands can be tricky because of stand hydrology, so attention to micro sites and persistence will be important.

Recommended replacement trees, as ranked by the experts:

Northern Wet Forest:
(11 out of 21 species)
- Tamarack
- White cedar
- American elm (disease resistant)
- Black spruce
- Balsam poplar
- Yellow birch
- Balsam fir
- Red maple
- Quaking aspen
- Ash (for genetic material)
- Silver maple

Southern Wet Forest:
(10 out of 21 species)
- American elm (disease resistant)
- Silver maple
- Basswood
- Red maple
- Willow
- Bur oak
- Yellow birch
- Ash (for genetic material)
- Box elder
- Red elm

Opposite page: General decline in wetland black ash near Cloquet, Minnesota

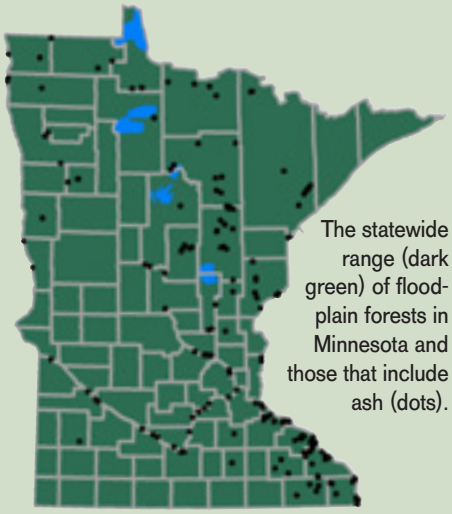
Steven Katovich, USDA Forest Service, Bugwood.org

Ash in the Floodplain Forest System

GLOSSARY

floodplains: *The level or nearly level land with alluvial soils on either or both sides of a stream or river that is subject to overflow flooding during periods of high water.*

riverine: *All wetlands and deep water habitats contained within a natural or artificial channel that periodically or continuously contains moving water, or that forms a link between two bodies of standing water.*



The statewide range (dark green) of floodplain forests in Minnesota and those that include ash (dots).

The Floodplain Forest (FF) occurs on ***floodplains***, creek bottoms, and ***riverine*** terraces. These landforms are essentially flat, following the river's gradient. The soils in a floodplain are developed on river sediment, and the surface is commonly fluted with shallow channels and levees in a complex, swirling pattern. Floodplains are annually inundated by spring runoff; terraces and bottoms are inundated occasionally during flood events. Even at low water, the water table is normally within reach of tree roots, meaning that FF trees must solve the same problem of root respiration as the trees in the Wet Forest Plant Community. FF differ from

Photo: J.C. Lucier

Canada moonseed is a plant found in the Floodplain Forest System

Floodplain Forest System

Photo: Greg Lavaty

The Cerulean warbler has shown the steepest decline of any warbler species according to the Breeding Bird Survey. It has suffered an 83% decline over the last 40 years. The decline is attributed, in part, to the loss of bottomland habitat.

WF because organics (non-living material derived from living organisms) do NOT tend to accumulate on the surface. That means there is a water flow that delivers incredible amounts of nutrients to the FF sites. To live on an active floodplain, a tree must:

- tolerate inundation, root and bole burial by sediments;
- resist erosion;
- survive wounding from ice floes; and
- be able to invade open, fresh-soil habitats.

Common Trees:
- Silver maple
- Green ash
- Black ash (northern MN)
- White ash (southern MN only)

Occasional Tree:
- American elm
- Basswood
- Box elder
- Hackberry

Silver maple is the tree most adapted to Minnesota floodplains and it strongly dominates the forest. However, creek bottoms, abandoned terraces, and higher ***microsites*** on the active floodplain approach WF habitat - and ash does well there. Ash seedlings occur in 95% of all FF, and ash trees are found in 88% of them – indicating that the ash has good success at recruiting seedlings to the canopy. Green ash is most common; occurring in 53% of all FF and it contributes 16% of the trees on average. Black ash is frequent; occurring in 38% of all FF, accounting for about 21% of the trees on average.

In general, black ash is more common in northern Minnesota and green ash more common in the south. White ash is limited to southern Minnesota and occurs in just trace amounts on FF sites. In addition to silver maple and ash, most (95%) floodplain and terrace forests are mixed with some other trees.

No Minnesota ***conifer*** is tolerant of flooding, and thus you will not find them in the FF community. Shrubs and small trees are essentially absent from any surface that floods regularly; rather vines are more likely to be found than are woody understory plants.

GLOSSARY

microsites: *A small part of an ecosystem that differs markedly from its immediate surroundings.*

conifer: *A cone-bearing tree (e.g. pines, firs, spruce, cedars, redwoods, larches etc.).*

Photo: Fred Harris

Vines:
- Wild grapes
- Virginia creeper
- Canada moonseed

Herbaceous plants:
- Ostrich fern
- Wood nettle
- Stinging nettle
- Tall coneflower
- Honewort
- Jewel weed
- Carrion-flower
- Sweet-scented bedstraw
- Side-flowering aster
- Ontario aster
- Kidney-leaved buttercup

Grasses:
- Rice cut grass (native)
- Virginia wildrye (native)
- Reed canary grass (invasive)

Terrace and floodplain forests in particular are not especially diverse communities. On average, 33 species of plants are found in 400m^2. Because of the abundance of moist mineral soil, a significant portion of the flora consists of germinating plants – many of which will not survive for long. Thus, the average number of persistent plants is rather low, the lowest of any system with ash trees.

Some rare plants and animals are dependent upon floodplain and terrace forest habitat in Minnesota.

Water & Wood: Good & Bad

Riparian forests provide a long corridor for animal habitat and migration. Natural EAB movement will be easiest along riparian corridors, effectively spreading it locally at 2-4 miles per year. Riparian forests are important because they provide shade to cool streams and normal amounts of fallen trees for wood habitat in the water. This is especially important in sand-bedded streams that lack cobble and gravel sites for spawning, rearing, and invertebrate attachment. These corridors also provide overhead cover.

Wood in rivers is a good thing; however, too much wood can cause silt and fine sand to cover spawning and rearing

Photo: Sandy Verry

Wood jams occur approximately every 300-400 feet on the Rat Root River in northern Minnesota.

Opposite page: Floodplain Forest stand

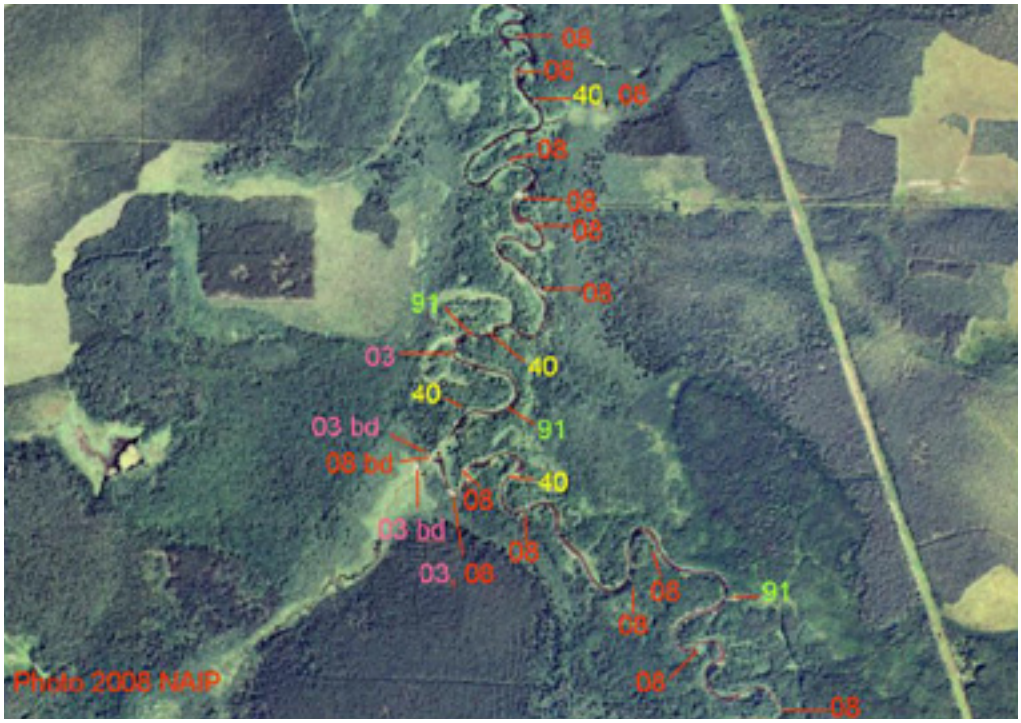


Photo: Sandy Verry

Excessive wood dams or beaver dams occur when early succession forests are perpetuated along streams, or when abnormal tree mortality occurs. This is the Rat Root River in northern Minnesota.

sites and lead to the widening of the river (the water cuts around the jams). Solid jams back up water causing silts and fine sands to deposit over spawning gravels. Over-wide channels also cause excessive deposition of silts and fine sands. Normal wood jams in rivers are a good thing if they occur at normal rates and the jam does not block the river. When wood jams block more than about 1/3 of the cross sectional area of a channel (area from the lowest bank top across the river and back along the channel bottom) they slow the water down and fine sand and silt, normally spit out on the floodplain, is deposited over spawning gravels. Wood jams and low beaver dams that occur every 1200 feet or so are normal; however, when wood jams occur every 300 to 400 feet, they are excessive and spawning habitat is degraded.

Excessive wood jams or beaver dams occur when ***early succession*** forests are perpetuated along stream corridors or when abnormal (but natural) tree mortality occurs. For example, wood jams occur every 300 to 400 feet on the 25-ft wide Rat Root River in northern Minnesota because of the wide spread mortality of elm killed by Dutch elm disease during the 1990s. This can also occur in typical elm-ash-spruce stands along stream corridors if emerald ash borer kills large amounts of ash.

Wider late-successional stands are needed along incised channels

Streams in Minnesota receiving the highest (worst) turbidity classifications are ***incised streams***. Normal stream channels have a floodplain on one or both sides. Often where the stream runs up against a high bank on one side (a terrace) it has a lower, floodplain, bank on the other side. Normal streams have access to this floodplain (on one or two sides) during the average spring runoff period when channels usually fill to the top of and just over the lower bank in two out of three years. The bottom of incised channels has down cut (several feet) and flow during the normal spring runoff period does not make it up to the lower bank. In this situation water is trapped in the channel, velocities are high and excessive bank undercutting

GLOSSARY

early succession: *The process by which one plant community is gradually replaced by another plant community. This may happen 'early' in the process or 'late;' thus the terms "early succession" and "late succession" are used to describe this process.*

incised stream: *Slopes along a creek, stream, or river that are eroded in a downward fashion.*

occurs leading to extensive bank failures causing high turbidity levels in the stream water.

Trees can help reduce the amount of bank failure because their roots extend 5 to 7 feet below the bank. They bind the soil and keep the bank drier during the growing season with their high evapotranspiration. Bank failures may extend 10 to some 300 feet away from the river depending on how deeply the river has incised.

Along the Littlefork River in northern Minnesota near the town of Littlefork, the river has downcut nearly 8½ feet and yields one of the highest turbidity ratings in the state. Bank failures along the Littlefork River extend up to 350 feet from the river. Along incised river channels, forests should be managed for late succession forest stands with near 100% forest canopies. The width of these forests should be about the width of bank failures seen along the channel.

Special wildlife considerations

Species that are most likely associated with the Floodplain Forest include the Cerulean warbler, red-shouldered hawk , red-bellied woodpecker (south expanding north), great blue heron, green heron (more south), blue-gray gnatcatcher (south), prothonotary warbler. Amphibian and reptile species include: blanding's turtle, wood turtle, wood frog, leopard frog, and mink frog. Mammals include the red bat and silver-haired bat. Note that many of these species use other habitats, in addition to the floodplain forest.

Survey Recommendations: Floodplain Forest

Hydrology is impacted more by natural drainage than tree loss. Death or removal of ash will change stream ***morphology***. Better water drainage in these sites will promote tree replacement.

When a harvest is viable, ***select harvest*** may be the best silvicultural practice in the Floodplain Forest. Harvest only when ground is frozen or dry. On quality sites continue to manage for quality ash. On poor sites do not harvest unless a harvest achieves specific objectives. Ash phloem reduction strategy is meant for EAB management not ash management, but it could be considered when managing these stands as one of many considerations.

Recommended replacement trees (as ranked by the experts):

Northern Floodplain Forest
(10 out of 17 species)
- American elm (DED resistant)
- Silver maple
- Basswood
- Bur oak
- Swamp white oak
- Balsam fir
- Box elder
- Cottonwood
- River birch
- Paper birch

Southern Floodplain Forest
(11 out of 17 species)
- Swamp white oak
- Cottonwood
- American elm (DED resistant)
- Silver maple
- Basswood
- Black walnut
- River birch
- Bitternut hickory
- Box elder
- Hackberry
- Rock elm

GLOSSARY

morphology: *The external and internal form and structure of whole plants, organs, tissues, or cells.*

select harvest: *A cutting that removes only a portion of trees in a stand.*

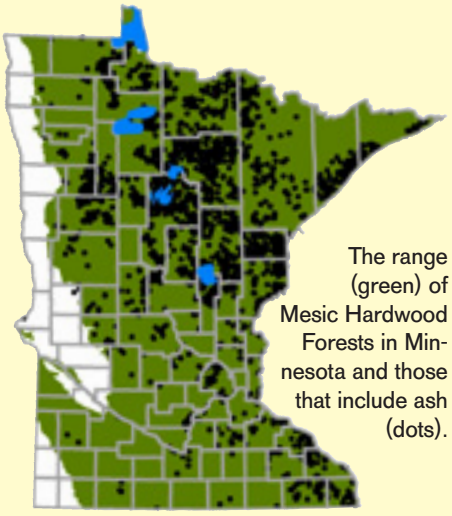
Ash in the Mesic Hardwood System

GLOSSARY

anoxia: *Meaning lack of oxygen.*

dominant: *An individual or species of the upper layer of the canopy.*

co-dominant: *Defines trees with crowns forming the general level of the main canopy in even-aged groups of trees, receiving full light from above and comparatively little light from the sides.*



The range (green) of Mesic Hardwood Forests in Minnesota and those that include ash (dots).

Mesic Hardwood (MH) forests occur on upland sites with soils that retain water, and in settings where wildfires are infrequent. These forests are characterized by continuous, often dense, canopies of deciduous trees. Beneath the main canopy are successively shorter layers of vegetation, composed of seedlings, shrubs, and herbs that are adapted to a shady environment. Plants in MH communities have access to predictable supplies of water and nutrients, but their growth is limited by a lack of light.

Typical MH sites are buffered from seasonal drought by fine-textured soils that are capable of holding or perching rainfall. At the same time, these soils are well drained. This means the roots of the trees rarely suffer from diminished respiration due to soil ***anoxia*** (lack of oxygen). Nutrients are rapidly recycled by comparison to the other forest types.

For most of Minnesota, sugar maple and basswood are considered the ***dominant*** trees on MH sites; however, the hallmark of these forests is their tendency to be of mixed composition usually involving 4-6 common species. Ash is a fairly common ***co-dominant*** species of the MH forest. The MH System is the only place where white ash occurs in noticeable abundance. Another important feature of the MH forests is a mixed canopy and high diversity of understory woody plants.

Ash is common, 66% of sites have ash seedlings. Ash occurs as trees on 25% of the sites. In an average stand, about 10% of the trees are ash: green and rarely, white ash which only occurs in southeastern counties.

Common Trees:
- Sugar maple
- Basswood
- White ash
- Green ash
- Black ash
- Ironwood
- Red oak
- Red maple
- Paper birch
- Yellow birch
- Quaking aspen

Shrubs:
- Beaked hazelnut
- Mountain maple
- Chokecherry
- Pagoda dogwood
- Prickly gooseberry
- Downy arrowwood
- Juneberries
- Fly honeysuckle

Herbaceous Layer:
- Lady fern
- Bracken fern
- Rattlesnake fern

Mesic hardwood forests have a diverse array of wildflowers. Some of these plants, the ***ephemerals***, make their entire living in a few weeks before and during leaf-out of the maples.

Wildflowers:

- Spring beauties
- Dutchman's breeches
- Wild leeks
- Dwarf raspberry
- Large-leaved aster
- Sarsaparilla
- Yellow & sessile-leaved bellworts
- Canada mayflower
- Early meadow rue
- Clayton's sweet cicely
- Rose twistedstalk
- Hog peanut
- Wild ginger
- Wood anemone
- Yellow violets
- Sweet-scented bedstraw
- Zig-zag goldenrod
- Bluebead lily
- Hairy Solomon's seal
- Maryland black snakeroot
- Hepatica
- Starflower
- False Solomon's seal
- Wild strawberry
- Red baneberry
- Jack-in-the-pulpit
- Bloodroot

Grasses and sedges are not normally abundant and the most common are: Pennsylvania sedge, peduncled sedge, and mountain rice grass. Where exotic earthworms have infested MH forests, Pennsylvania sedge can form large, continuous lawns. Mesic hardwood forests are diverse plant communities. On average, one can find 43 different species of plants in 400m^2.

Some rare plants and animals are dependent upon mesic hardwood forest habitat in Minnesota.

Earthworms should be considered as a serious threat to native regeneration in the Mesic Hardwood Forest type.

GLOSSARY

ephemerals: *Ephemeral plants are marked by short life cycles, usually 6-8 weeks. Ephemeral means transitory or quickly fading.*

Photo: MN DNR

A Mesic Hardwood forest

A Mesic stand in early Spring

Photo: Julie Miedtke

Earthworms & Ash: Making the Connections

GLOSSARY

duff: *The partially decomposed organic material of the forest floor beneath the litter of freshly fallen twigs, needles, and leaves.*

Earthworms may be 'tool of the trade' when it comes to fishing Minnesota's lakes. And they are considered rather good friends in the vegetable garden. However, earthworms are an unwelcome intruder in Minnesota's hardwood forests.

Minnesota's mesic hardwood forests developed in the absence of native earthworms. These forests grew after the last glaciers retreated. They contained a thick forest floor that served, and continues to serve as a perfect rooting medium for many species of forest herbs and tree seedlings.

Minnesota has no native earthworms. In the 1800s European settlers arrived, bringing with them European earthworm species in potted plants. European earthworms have been part of the habitats surrounding human habitation ever since. The European earthworm invasion changes the structure of forest soils. The ***duff*** layer is consumed by the worms so that the seedbed conditions on the forest floor change from deep leaf litter to bare mineral soil during summer. The soil is also compacted, leading to more runoff during heavy rainfall events; the availability of nitrogen and phosphorus is reduced.

Earthworm invasion accentuates the already negative impact of deer browsing on native plant and tree species. Combined, these changes make trees more sensitive to drought, make regeneration of some species like sugar maple and red oak difficult, lead to reduction in the diversity of native plants, and facilitate

Do NOT release earthworms!

Earthworms should be considered as a serious threat to native regeneration in the Mesic Hardwood Forest type. Earthworms are an unwelcome intruder in Minnesota's hardwood forests.

the invasion of undesirable plants like buckthorn, tatarian honeysuckle, and garlic mustard.

Although it is not possible to reverse the continued migration of the earthworms, there are things people can do to help the forests recover:

1. People have always been told worms are good for the environment, so at the end of fishing vacations they dump the leftover worms near the lake. Don't do this.
2. Replanting native plant species is another way to help forests recover from earthworm damage. Native plants, grown from locally harvested seeds, are now available. Native woodland plant species are becoming available through both public and private sources.

Hydrology and soil conditions of Mesic Hardwoods

Harvests of Mesic Hardwood ash forests should follow Minnesota ***Best Management Practices (BMPs)*** using either relative dry or frozen conditions that will support harvesting equipment without rutting soils more than 6-inches deep for distances of 100 feet or more. Management on these sites can target a management outcome of early-succession forests (usually beginning with a clear cut and, dominantly, aspen regeneration) developing into late-succession forests (with sugar maple, birch, balsam fir, basswood, white spruce, silver maple and ash) or the perpetuation of late-succession forests.

Survey Recommendations: Mesic Hardwood Forest

Gap phase dynamics will dominate forest regeneration. Ash decline and death will have limited impact on hydrology. One silviculture expert expressed concern about the hydrologic impacts of harvesting due to rutting and compaction in stands with perched water tables.

Ash should be harvested to minimize the impact of EAB in the Mesic Hardwood forest. On quality sites continue to manage for quality ash. Two experts pointed out that these sites are productive with high quality trees that are likely to have the most valuable ash which may also warrant their harvest and more management. Ash phloem reduction strategy is meant for EAB management not ash management, but it could be considered when managing these stands as one of many considerations.

Earthworms and deer browse should be considered as serious threats to native regeneration in the Mesic Forest type.

Recommended replacement trees (as ranked by the experts):

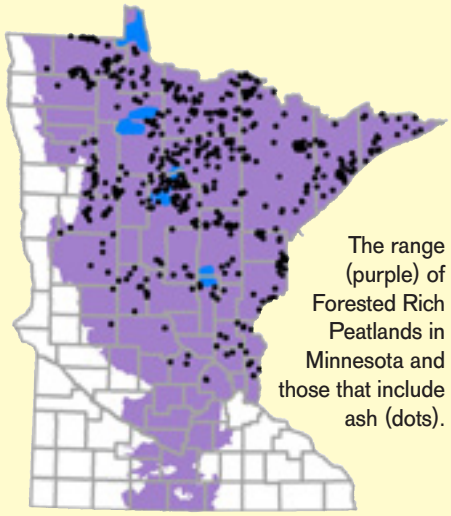
Northern Mesic Hardwood Forest
(11 of 29 species)
- Basswood
- White pine
- Bur oak
- Northern red oak
- Sugar maple
- American elm (DED resistant)
- Big-toothed aspen
- Quaking aspen
- White spruce
- Paper birch
- White cedar

Southern Mesic Hardwood Forest
(10 out of 29 species)
- Northern red oak
- White oak
- American elm (DED resistant)
- Bitternut hickory
- Black cherry
- Shagbark hickory
- Black walnut
- Bur oak
- Sugar maple
- Basswood

GLOSSARY

Best Management Practices: *BMPs are practical guidelines aimed at lessening non-point source pollution from forest management activities, such as road construction, skid trails, and log landings.*

Ash in the Forested Rich Peatland System



The range (purple) of Forested Rich Peatlands in Minnesota and those that include ash (dots).

Forested Rich Peatland (FP) forests are dominated by conifers, tamarack, northern white cedar, black spruce, and balsam fir. They occur on organic soils that are deep, actively forming peat. Sphagnum moss is the principle peat-forming plant, although the woody remains of trees and shrubs contribute significantly to peat volume. Peat forms because FP sites are continuously water-logged. By comparison to the atmosphere, water offers very little of the oxygen that is needed to decompose plant remains - thus the buildup of organic peat. Furthermore, Sphagnum moss depletes the groundwater of its dissolved nutrients, leaving the site acidic and so poor that the site cannot sustain large populations of decomposing microbes even though there is a large supply of "food." FP sites are, in general, poor habitat for ash trees. Like many environments, ash seedlings are fairly common, appearing in 31% of all FP forests. But, the chances of growing into a tree are slim – just 4% of FP forests actually have ash trees and, when present, they account for only 4% of the trees. Achieving tree status probably occurs on microsites where the peat is thin enough

Survey Recommendations: Forested Rich Peatlands

There will be minimal effect on Forested Rich Peatland Systems because conifers will continue to dominate these stands. Harvest when ground is frozen or dry; however, ash is too small a component of the forested rich peatland system to manage for its replacement.

Recommended replacement trees (as ranked by the experts):

Forested Rich Peatland (north only): 10 out of 11 species

- Black spruce
- Tamarack
- White cedar
- Balsam fir
- White spruce
- American elm (DED resistant)
- Paper birch
- White pine
- Quaking aspen
- Red maple

Forested Rich Peatland System

for ash roots to reach mineral soil. Nearly all occurrence of ash on FP sites is black ash. Green ash is rare and white ash doesn't occur in the northern part of the state where Minnesota has its peatlands. Diversity in FP forests is 40 species in 400m^2. Some rare plants and animals are dependent upon forested rich peatland habitat in Minnesota.

Common Trees:
- Tamarack
- Northern white cedar
- Black spruce
- Balsam fir
- Paper birch
- Red maple
- Black ash

Tall shrubs:
- Rough alder
- Bog birch
- Red-osier dogwood
- Alder-leaved buckthorn

Half-shrubs:
- Labrador tea
- Creeping snowberry
- Cranberries
- Mountain fly honeysuckle
- Red raspberry
- Velvet-leaved blueberry

Ferns:
- Marsh fern
- Crested fern
- Shield fern

Wildflowers:
- Dwarf raspberry
- False Solomon's seal
- Bunchberry
- Naked miterwort
- Starflower

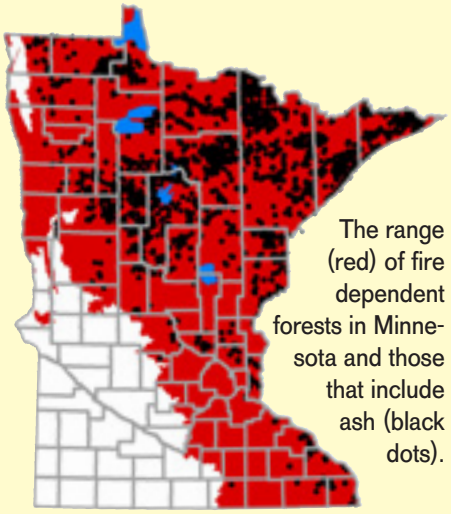
Photo: Joy Viola/Northeastern University, Bugwood.org

Bunchberries are indicator plants of the Forested Rich Peatland System.

- Goldthread
- Canada mayflower
- Cowslips
- Twinflower
- Tufted loosestrife
- Sweet-scented bedstraw
- Marsh cinquefoil
- Water horehound
- Red-stemmed aster
- Marsh bellflower
- Willow-herbs
- Great water dock

Grasses & Sedges:
- Bluejoint
- Fowl manna grass
- Soft-leaved sedge
- Bristle-stalked sedge
- Three-fruited bog sedge
- Interior sedge
- Poor sedge

Ash in the Fire-dependent System



The range (red) of fire dependent forests in Minnesota and those that include ash (black dots).

Many forest types, like jack pine savanna are fire-dependent. The only way to maintain these types on the landscape is by reintroducing fire.

Fire-dependent forest and woodland communities (FD), as the name implies, are strongly influenced and shaped by wildfires. Fire is important because it is the main source of mortality that selects among the species and causes the forest to regenerate. Fire is the principal means of releasing nutrients and reducing carbon stores. It does this in a way that is episodic and unpredictable when compared to systems that are adapted to annual cycles of nutrient availability. Fire creates situations where nutrients are lost rather permanently from sites by leaching them below the rooting zone and by lateral transport to wetlands, lakes, or streams.

FD communities occur on sites that cannot retain very many nutrients or much water, and fires contribute further to this by producing ***hydrophobic*** (water-repelling) compounds that end up in the soil. The plants that live in these communities are obviously able to survive fires

GLOSSARY

hydrophobic: *Having little or no affinity for water molecules.*

Red pine stand with ash in understory.

Photo: Julie Miedtke

and re-colonize a burned landscape.

Ash is poorly adapted to fire and the nutrient-poor soils of FD sites. However, fire-suppression efforts have opened FD sites to modest invasion by ash. About 20% of all FD forests have ash regeneration, but just 3% have ash trees – meaning that recruitment is poor. When present, ash trees account for about 8% of the trees on FD sites. Green ash is the most successful species in FD forests, with regeneration in 15% of the sites. As a tree, it occurs in 3% of FD forests and about 16% of the trees are ash when it is present. White and black ash occur in trace amounts on FD sites.

Common trees:
- Jack pine
- Red pine
- White pine
- Quaking aspen

Shrubs:
- American hazelnut
- Poison ivy
- Tall blackberry
- Sand cherry
- Wintergreen
- Prairie willow
- Wild rose
- Juneberry
- Grey dogwood
- Snowberry
- Pipsissewa
- Bearberry

Herbaceous plants:
- Common oak fern
- Running clubmoss

Survey Recommendations: Fire-dependent System

The effect of ash mortality due to EAB will be minimal in Fire-Dependent System. On quality sites continue to manage for quality ash. Gap phase dynamics will dominate regeneration. In areas in close proximity to EAB do not assume an unlimited number of growing years for ash trees. Reduce the ash component to less than 20%. Ash should be scattered throughout the stand rather than having areas with high densities of ash. Prepare for replacement to invasive species, for example buckthorn.

Recommended replacement trees (as ranked by the experts):

Northern Fire Dependent
(10 out of 31 species)
- Jack pine
- White pine
- Northern pin oak
- Quaking aspen
- Bur oak
- Northern red oak
- Paper birch
- White oak
- Big-toothed aspen
- Red pine

Southern Fire Dependent
(10 out of 31 species)
- Northern red oak
- Northern pin oak
- Black oak
- White oak
- White pine
- Bur oak
- Shagbark hickory
- Black cherry
- Jack pine
- Bigtoothed aspen

Fire-dependent System

- Ground pine
- Lady fern

Grasses and Sedges:
- Bluejoint grass
- Big bluestem
- Slender wheatgrass
- Poverty grass
- Fringed brome

Wildflowers:
- Sweet coltsfoot
- Blue giant hyssop
- Northern bedstraw
- Hoary puccoon
- Wild bergamot
- Wood betony
- Lead plant
- Pale vetchling
- Veiny pea
- Pale bellwort
- Starry false Solmon's seal
- Yarrow
- Pussytoes
- Spreading dogbane
- Cow wheat
- Bastard toadflax
- Tall meadow rue

Photo: DNR/Kurt Rusterholz

Black ash-conifer swamp located in Big Island Scientific and Natural Area, Pelican Lake in St. Louis County.

This is your field copy – take it with you into the woods and ID your ash system.

A general overview of ash species dominance in Minnesota's forest systems

	Wet Forest system	Floodplain Forest system	Mesic Hardwood system	Forested Rich Peatland system	Fire-Dependent system
Main tree species in system	Green and black ash, northern white cedar. Sometimes balsam fir, American elm, red maple.	Silver maple, American elm, green ash, black ash, hackberry, basswood, boxelder, white ash.	Sugar maple and basswood, paper birch, quaking aspen, red oak, yellow birch, white ash, green ash, black ash, ironwood, red maple.	Lowland conifer dominated; tamarack, northern white cedar, black spruce, balsam fir, paper birch, red maple and black ash common, but considered to be 'misplaced' or 'off site'.	Predominately upland conifers. Jack, red, and white pines, quaking aspen, paper birch, white spruce, bur oak, northern pin oak, northern red oak, bigtooth aspen, red maple. Some balsam fir.
Ash species and its dominance	Ash and white cedar dominate these sites. All sites have ash regeneration and 75% have ash trees on them. In an average stand, ash contributes 34% of the trees.	Ash seedlings occur on 95% of the sites. Ash trees are found on 88% of the sites. Green ash accounts for 16% of the trees. Black ash, in the north, accounts for 21% of the trees.	Ash is common. 66% of sites have ash seedlings. Ash occurs as trees on 25% of the sites. In an average stand, about 10% of the trees are ash; green, black and, rarely, white ash which only occurs in the southeastern counties.	Poor habitat for ash. Its presence is likely where ash roots can reach the mineral soil. Seedlings are common but only 4% make it to tree size.	Historically, ash was very infrequent. With fire-suppression in the last century, ash has an increased its presence. Primarily green ash. 20% of sites have ash seedlings but only 3% have ash trees.
Characters that shape this system	Found along margins of lakes, rivers and peatlands. Stands can also occur in shallow depressions where the water table is high. Water peaks in the spring and decreases in depth throughout the summer. This seasonal variability of water is the hallmark of the wet forest system.	Regular inundation by spring floods. Commonly found on flat lands along streams and rivers. Tree stems and roots must withstand a lot of mechanical damage.	Wildfires are very infrequent. The limiting factor is sunlight because the canopy is continuous, dense, and multi-layered.	Occur on deep and actively forming peat. Sphagnum moss is most common peat former.	Wildfires kill trees, set conditions for regeneration, episodic release of nutrients over decades of time.
Soils	Soils are under water or saturated during the growing season. This limits the oxygen and nutrient availability and the rate of decomposition. So a mucky layer is created on the surface of the soils. Peat, if formed, only reaches a depth of 10 to 40 inches.	Lots of nutrients are deposited in soils with each flood. Mucky layers do not accumulate on the soil surface.	Soils are able to retain water so many tree species can grow there. Nutrients are rapidly recycled.	Deep peat soils. Soils are continuously water-logged so they are acidic, have low oxygen and are poor in nutrients.	Dry soils that are nutrient poor due to a long history of wildfires. Nutrients also lost through leaching down into the soil.
Shrubs and vines	Rough alder Mountain maple Beaked hazelnut Red-osier dogwood Swamp red current Virginia creeper Dwarf raspberry	Wild Grape Virginia creeper Canada moonseed *Note:* *Shrubs are generally absent from floodplain forests.*	Beaked hazelnut Mountain maple Chokecherry Pagoda dogwood Prickly gooseberry Downy arrowwood Juneberry Fly honeysuckle	Rough alder Bog birch Red-osier dogwood Cranberry Labrador tea Creeping snowberry Mountain fly Honeysuckle Alder-leaved buckthorn	American hazelnut Poison ivy Tall blackberry Sand cherry Wintergreen Prairie willow Wild rose Juneberries Grey dogwood Snowberry
Ferns and related plants	Lady fern Oak fern	Ostrich fern	Lady fern Bracken fern	Marsh fern Crested fern	Lady fern Common oak fern

Chapter 6

Wildlife Among the Ash

Ash stands and ash trees are used by a variety of wildlife species including large and small mammals, birds, reptiles, and amphibians. When ash stands and trees are older, they provide value as feeding sites for woodpeckers, nuthatches, and chickadees.

Cavities in these same trees, when found near permanent wetlands, are also used by several species of waterfowl including wood ducks, hooded mergansers, and goldeneyes.

In northern Minnesota, large cavities may also be used by fisher as den sites. Several species of birds use ash stands as nesting sites including great blue and green herons, and Cerulean warbler. Birds, however, tend to be linked to habitat type not tree species so while birds may be temporarily impacted by the loss of ash, they are likely to adapt and move to other trees in the surrounding area. As younger trees or stands, ash is an important source of food for white tailed deer and moose. Forest landowners should manage for a variety of age classes when managing their ash resource because of the various values those resources provide in different age classes or growth stages.

GLOSSARY

cavities: *Holes in trees sometimes used for nesting and reproduction by wildlife species, most frequently birds or small mammals.*

For more information on rare species on your property, see Appendix C, on page 65.

Photo: Douglas Brown

Moose are one mammal species found in ash systems

Survey Recommendations: Wildlife

Until snags fall due to ash mortality aerial predation may increase on some birds. One wildlife expert pointed out, "This will be dependent on the density and age of other components in the stand." Secondary insects and diseases on ash will increase after EAB arrives in a stand. According to one entomologist "secondary insects will not play a significant role in increasing ash mortality; however, once these trees die, the wood boring insects and decay fungi will increase food for foraging wildlife. These dead trees may provide some opportunity for cavity nesters but experience from Michigan has shown that dead trees fall down quickly." In the short term, more snags will result from tree mortality. Temporarily downed woody material will increase salamander habitat. Woodpecker numbers will increase. One entomologist pointed out, "I get the impression that woodpeckers are not food limited - which also limits their effectiveness in controlling EAB numbers. When there are 300 EAB in a stand and the woodpeckers eat 200 it is great, but when there are 3000 EAB and the woodpeckers eat 200, it doesn't help much." In the short term cavity nesting birds will increase but several experts pointed out these trees aren't likely to remain standing for very long.

After ash mortality, cowbird predation will increase in open canopy forests; however, two experts observed that cowbirds are typically more problematic in fragmented landscapes rather than solid forest blocks. Neo-tropical song bird migration stop-overs would be impacted. According to one ecologist this may be a problem "to a small extent in some stands with high ash dominance in the north or possibly to a large extent in certain river floodplains in the south where an ash stand might be the only forest in an agriculture dominated landscape."

Another wildlife export pointed out it's not clear how ash motility may impact bird migration routes. Beaver may increase after ash replacement has begun. Ash flower gall may decline. One final note from a forest ecologist, "A lot of unique microhabitat structures are present and stands are very important for biodiversity (amphibians, plants). Particularly if invasive plants take over, then the habitat will not support as many wildlife species and native plants."

Photo: Darek Bakken

Plant and animal species designated as "Rare, Threatened, and/or Endangered" may be found in any of the ash systems discussed in this Guide. If you wish to look up these species, refer to Appendix C: "Rare Species Guide," page 65.

Hooded merganser

Chapter 7

Other Implications of EAB and Ash Trees

Legal & Financial

Falling dead trees may injure people or damage vehicles and equipment, so cut down hazardous trees along trails and roads. Such actions will reduce the chances of an accident occurring which may result in a lawsuit that seeks a damage payment.

The loss of trees killed by EAB does not constitute a casualty loss reportable on income tax returns. A casualty loss must be sudden and unexpected, but infested ash trees may live for several years and their death is expected.

If you are managing your woodland as a business or investment, then you may have inventoried your timber near the time it was acquired and set up a timber capital account showing the timber volume and the cost you incurred to acquire it. When trees are killed by EAB, your volume is reduced, but your cost basis for timber will remain the same.

Your depletion unit will rise, however, since you have a lower volume over which to spread your cost basis. A depletion unit is the cost per unit of timber (cords or 1000 board feet) that you incurred to produce your timber. When you sell timber, you can deduct a depletion allowance for the volume sold.

Ash log with EAB larval galleries

Photo: MN Dept. of Agriculture/Mark Abrahamson

Photo: Di Bedard

The result of an emerald ash borer invasion

Wildfire, EAB, and Ash

The Emerald Ash Borer's Effects on Wildfire Potential

Ash mortality may result in increased potential for wildfire during the early spring and late fall months when the herbaceous vegetation is dry. Ash species are generally associated with vegetation communities that are considered to be fire resistant except during periods of extended drought. Therefore, in those areas where ash grows in association with other tree species, such as in northern hardwood stands or in mixed balm of Gilead/white cedar/red maple lowlands there will be little noticeable change in fire potential when the EAB invades forest stands and kills ash trees.

Standing ***snag*** trees will lose their bark and shed branches within a few years, minimizing fire hazard. Coarse woody debris will decompose quickly and become ***punky*** (soft and crumbly), keeping fuel moisture at levels too high to support efficient combustion. Other tree species will quickly fill in the gaps left where ash once grew, as was the case when the American elm component was lost in these stands 30 to 40 years ago. The situation could be different in pure lowland black ash stands where typically a brush understory is lacking and grasses and sedges dominate the herbaceous layer. Since these ash types are considered a climax community, recruitment of other potential overstory species may be delayed. The existing herbaceous layer will respond to increased sunlight and will likely increase in density and mass. Wind exposure will also increase as the overstory declines.

GLOSSARY

snag: *A standing, generally unmerchantable dead tree from which the leaves and most of the branches have fallen.*

punky: *Soft, crumbly decayed wood that has been attacked by fungus, sometimes used as tinder.*

Defects in ash trees

There are as many ways for trees to fail as there are trees. An ice storm can overload all the branches on a tree, a blustery wind can blow down a tree if its roots are restricted or a cracked tree can fail just under its own weight.

Trees are designed to easily withstand the normal windstorms and winter storms that occur, yet we have all seen trees that have failed. Trees fail when the load (weight and motion of the crown) exceeds the mechanical strength of their branches, stems or root systems. This is true for both sound and defective trees, but defective trees can only withstand a fraction of the load that sound trees can withstand. Defective trees fail sooner than sound trees.

Epicormic branching

Photo: Ed Czerwinski

A sound tree becomes potentially dangerous when the tree's woody structure is weakened by one or more defects. Most defects can be linked to past wounding and decay, pest infestations, severe storms, or to growing conditions that limited the root system. Since defects, the old injury sites and nearby wood, are structurally weaker than uninjured wood, the tree is predisposed to fail at the location of the defects. Defective trees can be found growing anywhere. Management of a defective tree is at the landowner's discretion. It is suggested that if defective trees or dead trees could fall onto structures, yards, fences, driveways or recreational trails, a landowner might consider removing them. On the positive side, defective and fallen trees provide wildlife habitat and other important ecological services. As a species group, ash are susceptible to two main defects; root system failure and branch failure. In many soil types, ash root systems are quite shallow, making the trees prone to windthrow. Commonly the entire tree and much of its root system tip over during strong winds, especially in exposed locations. Branches are likely to fail at the junction of the branch and the stem due to the presence of bark growing inside the tree and/or the presence of serious decay in the same location. Branch failure is more prevalent in large diameter trees.

For information on where to find the full resource on defects in ash trees see Appendix D, page 66.

Windthrow Mortality

All hardwood forests in their late-succession stages (older ages) can be perpetuated where a closed canopy is maintained over decades. Regeneration is by seedling release in canopy gaps (chronic ***windthrow***), or by thinning overstocked stands. Thinning removes trees to where remaining tree canopies occupy 50 to 80% of the land area. For protection against excessive windthrow and provision of favorable riparian and stream attributes, thinning down to a canopy closure of 80% is recommended.

Exposure of stands along long edges will greatly increase the likelihood of excessive windthrow. Studies of strip cut forests in Minnesota show the balance between stand growth and tree mortality is a function of the total stand edge and the height of the trees. Along stream corridors the stream produces one stand edge and cutting of forests landward of a forest next to the stream produces a second edge. Maintaining continuous-canopy stands along the stream or river at least 125 feet wide will ensure that normal windthrow mortality will not exceed stand growth over time. A wider stand will maximize stand growth. Many riparian forests in the Lake States have poor stocking (low canopy closure and not enough trees); though studies of the cause of this poor stocking are needed, excessive wind mortality is a prime candidate.

GLOSSARY

windthrow: *A tree uprooted or broken by wind; also called "blowdown".*

Photo: Eli Sagor

Blowdown in the Boundary Waters Canoe Area Wilderness, 1999

Appendices

Appendix A

Guidelines for managing sites with ash to address the threat of emerald ash borer on DNR Forestry-administered lands

BACKGROUND

The ash genus (Fraxinus) in Minnesota comprises some 900 million trees and is the second most common hardwood tree genus in the state. EAB was discovered in the United States in 2002 and is now present in 13 states and 2 Canadian Provinces. It was found in Minnesota in 2009. EAB populations can spread rapidly in infested firewood, logs, and ash nursery stock. Therefore, it is assumed that EAB will soon infest Minnesota's forested areas and cause significant impact to the ash resource. Experience from other states has shown that EAB kills 99+% of the ash in a stand once that stand becomes infested. This level of impact is greater than what occurred with American elm following the introduction of Dutch elm disease to Minnesota.

To date there has been no evidence of resistance to EAB within any North American ash species. Resistance does exist in some Asian ash species. Subtle differences in susceptibility to EAB between white, green, and black ash have been reported, but those differences are minor and should not influence management options. All three ash species in Minnesota will likely succumb to EAB attack.

SCOPE

This document applies to:

- Forested stands classified as ash covertype
- Forested stands with an ash component of at least 20% of stand basal area but not typed as an ash covertype. Native plant communities where ash is and can be significant include: FDw44, MHs49, MHw36, MHc47, MHn46, FFs58, FFs59, FFn57, FFn67, WFs57, WFw54, WFn53, WFn55, WFn64.
- Forested stands with ash that are free of EAB occurrence and are greater than 25 miles from the closest known EAB infestation. This distance will allow multiple entries into a stand based on an average, "natural" movement of EAB of ~2 miles per year.

ASH MANAGEMENT OBJECTIVES

- Landscape perspective: Manage ash populations in the landscape to protect sensitive wetland ecotypes, reduce outbreak costs, and restrict emerald ash borer introduction and spread without eliminating ash within forest ecosystems.
- Stand perspective: Create conditions that will reduce potential impacts and increase the resiliency of forested stands by
- Keeping forested sites forested
- Maintaining an ash component but reducing the size and number of ash in the stand.
- Increasing tree species diversity.
- Management objectives should focus on ecosystem health and management, not on the emerald ash borer. The intent is to limit habitat attractiveness to EAB.
- The Division of Forestry will work within its nursery program and with other partners for maintaining representative samples of genotypes but not for processing seeds for reforestation.

CAVEATS

- There is a likelihood that the vast majority of ash trees in Minnesota will be killed by EAB regardless of the type or magnitude of actions taken.
- The large extent of the ash resource, particularly black ash, will likely mean that sufficient management actions will not occur in all stands prior to EAB becoming established in Minnesota. Forested sites will be altered or lost.
- Little is known through research and experience how to maintain black ash forested sites as forested communities once the black ash is killed or removed. On-going research and knowledge gained through experience that can be passed along to all managers will be critical to meeting long term ash management objectives. Therefore, this document presents interim guidance that will change as knowledge from research and experience is gained.

Managing forested stands with ash

- **INTERIM DIRECTIVE FOR ALL STANDS WITH ASH**
  The current scientific evidence does not support investments in artificial regeneration of ash species or management practices implemented to expand or regenerate ash populations. These activities could also compromise efforts to protect sensitive wetland ecosystems through canopy diversification, reduce forest vulnerability and potentially compromise EAB response efforts.
- Ash species should not be planted on DNR administered lands for ornamental, shade or reforestation purposes. In implementing forest management practices do not structure operations to intentionally favor the regeneration or reestablishment of ash.
- Rationale: In order to avoid perpetuating habitat for EAB for future generations, the current objective is to diversify ash dominated plant communities now and into the near future.
- Actions
- Do NOT plant ash seedlings on state administered lands or recommend ash seedlings for reforestation on private lands.
- Do NOT use ash seed in the mix for direct seeding on state administered lands or recommend ash seeds for direct seeding on private lands.

- Create conditions favorable for regeneration of non-ash tree species. Ash regeneration can be aggressive, particularly from stump sprouting; chemical application may be necessary to reduce ash on some sites.
- Prioritize opportunities to implement management practices in stands with ash immediately irrespective of EAB outbreaks.
- Rationale: Given the magnitude of the ash resource in Minnesota today, forest managers must make ash management a higher priority. The proximity of EAB and the uncertainty of knowing where EAB is currently infesting ash necessitate taking immediate actions to ameliorate some of the negative consequences that have been documented in other states.
- Actions
- Ash stands on the annual stand exam list should be scheduled for a management action that addresses the objectives above. Do not defer stands with ash for a later action. Schedule treatment as soon as possible.
- Work with the department's planning groups to revise SFRMP objectives and stand selection criteria to address the objectives listed above.

- **GUIDELINES FOR ALL STANDS WITH ASH**
- Reduce the stocking and average diameter of the ash component
- Rationale: Ash phloem is the larval food source for EAB. More phloem can support greater populations of EAB within any given area. The larger the tree, the greater potential to support higher EAB populations. Reducing the ash component may reduce future impacts and may help slow the spread of EAB.
- Actions
- Reduce the ash component to no more than 20% of current stand basal area.
- Focus on reducing the average diameter of the residual ash component. Focusing on reducing larger trees will be more effective than removing only poles and saplings. However, if scattered larger diameter trees are left to meet leave tree guidelines or wildlife considerations, remove a larger proportion of smaller diameter ash so that the overall average diameter of the residual ash is reduced from the average ash diameter before treatment.
- Leave other species as residuals during harvesting or regenerate other, non-ash species to maintain a forested cover.
- Use intermediate stand treatments that focus on a dominant thinning technique where larger trees are selected to be cut to reduce the size and amount of ash.
- Intermediate stand treatments are often precommercial. The cut material can be left on the forest floor if biomass opportunities are limited or non-existent. EAB will not utilize dead ash trees as host material. Leaving uninfested stems on the forest floor will not create EAB habitat.
- Multiple entries may be necessary. When non-ash reproduction is at least 2 - 3 feet in height, consider another ash reduction treatment.
- Reduce the concentration of ash.
- Rationale: A dispersed ash component can lessen the impacts to the stand by reducing the likelihood of EAB killing large areas of ash which may or may not have an understory of other tree species. Work to create and maintain scattered ash throughout the stand rather than maintaining pure or nearly pure ash areas within the stand.
- Actions
- In homogeneous ash areas, focus on thinning dominant and codominant trees where all ash above a prescribed diameter limit are cut resulting in a reduction in the size and number of ash in the stand. See basal area and diameter guidance above.
- Use scattered ash in the stand to meet the basal area goal above rather than relying on pure ash areas to meet this goal.
- Transition sites to a composition that favors non-ash species
- Rationale: Despite all management efforts, current experience seems to indicate that EAB will kill 99% of the ash in the stand regardless of ash tree size and spatial occurrence within the stand. The ultimate strategy must be to move stands away from ash and maintain the forest community by depending on other species.
- Actions
- Use the native plant community field guides to determine the growth stage and refer to Silviculture Interpretation, Table PLS-2, Abundance of trees throughout succession to identify favorable ingressing species. The DNR web site for ECS information is: http://www.dnr.state.mn.us/forestry/ecs_silv/interpretations.html
- Consider the regeneration strategies (tolerance) of non-ash tree species already on the site.
- If non-ash species are few or nonexistent, consider artificial regeneration. Try aerial seeding non-ash species as well as underplanting non-ash species even in the absence of any other kinds of stand treatment.
- Consider creating canopy gaps through hand felling or girdling to provide light conditions more suitable for the establishment of underplanted or seeded non-ash species. However, openings greater than 60 feet in diameter may encourage ash regeneration.
- Use the NPC tree table, Silviculture Interpretation Table R-1, Suitability ratings of trees, to select non-ash species best adapted to the site.

- **ADDITIONAL GUIDELINES FOR BLACK ASH**
- Protect the hydrologic functions of the site to maintain a tree cover.
- Rationale: The guiding principle for all black ash management decisions is to protect the hydrology of the site. Black ash, because of its abundance on some sites, often controls water levels in the stand. If the black ash is cut or dies off, water levels often increase and there is a chance sites will convert to wet meadows or become dominated by alder. The greatest concerns are black ash communities classified in the wet forest system (WF).
- Actions
- Use the Native Plant Community information along with stand site index to help guide management decisions. The greater the site index, the more flexibility in applying a management treatment that will not cause long-term alteration of the site.
- General site index guidance:
- SI = <45: Avoid all forest management actions. Do not spend resources on these sites.
- SI = 45-55: These sites may provide limited forest management opportunities. Extreme care must be taken on these sites when trees are harvested. These sites are appropriate candidates for understory planting or direct

seeding of non-ash species.
- SI = >55: Consider management for timber with the cautions listed below for specific NPCs. Ash reduction, salvaging, and regeneration by planting, underplanting, and direct seeding to non–ash species may be appropriate. Use the NPC tree table, Silviculture Interpretation Table R-1, Suitability ratings of trees, to select non-ash species best adapted to the site.
- When working in black ash stands, always monitor treatment results and apply lessons learned to future black ash management opportunities.

- **PRECAUTIONS FOR SPECIFIC NATIVE PLANT COMMUNITIES AT RISK**

The following communities are at risk for hydrologic damage if the tree cover is significantly altered. Generally, management actions should be lightly applied, and follow up monitoring is mandatory.

WFn55 – Northern Wet Ash Swamp
- When there is substantial aspen or balm of Gilead (bam) in the stand, use partial harvesting techniques such as 2-step shelterwood and strip clearcut, or use dominant thinning when the stand is not merchantable. Suckering aspen and bam will help avoid swamping the site.
- When substantial aspen or bam is lacking:
- Stands with a site index of 55 or greater, partial harvesting and dominant thinning are possible. However, extreme care should be taken by removing not more than 50% of the basal area at one time.
- Stands with a site index under 55, avoid harvesting and intermediate stand treatment but consider establishing non-ash species.
- Underplant or aerial seed appropriate species listed in the NPC tree tables, Silviculture Interpretation Table R-1, Suitability ratings of trees, to select species alternates to ash. Browse protection will be necessary.
- In the absence of any harvesting or intermediate stand treatments, consider hand felling or girdling to create gaps for the establishment of non-ash species.

WFn64 – Northern Very Wet Ash Swamp
- Avoid harvesting or intermediate stand treatments.
- In lieu of any harvesting, consider underplanting or aerial seeding appropriate species listed in the NPC tree tables, Silviculture Interpretation Table R-1, Suitability ratings of trees, to select species alternates to ash. Browse protection will be necessary.
- Consider creating small gaps by hand felling or girdling when underplanting and seeding.

WFs57 – Southern Wet Ash Swamp
- This is a rare community often found near springs, mostly in rugged topography of the Blufflands Subsection and along the tributaries of the Minnesota and St. Croix rivers.
- Avoid any harvesting or intermediate treatments in or immediately adjacent to these communities. Allow other tree species to naturally seed or develop in the understory.

Appendix B

Questions & Answers about Quarantines and Compliance Agreements

Q1. What is a quarantine?

A1. A quarantine is a temporary rule intended to help prevent a potentially dangerous or destructive pest or disease organism from spreading outside a known infested area into new areas. In the case of emerald ash borer (EAB), the quarantine is designed to limit the movement of potentially infested firewood or other materials such as live ash trees that might harbor EAB larvae.

Q2. As of November 2009, what areas of Minnesota are currently quarantined for emerald ash borer?

A2. As of October 2009, the EAB quarantine in Minnesota consisted of the counties of Ramsey, Hennepin and Houston. See the most current EAB quarantine in Minnesota. (www.mda.state.mn.us/en/plants/pestmanagement/eab/eabquarantine.aspx)

Q3. What are regulated articles?

A3. The following are three categories of regulated articles:

- The emerald ash borer (Agrilus planipennis),
- Ash trees (Fraxinus sp.), ash limbs and branches, ash stumps and roots, ash logs, ash lumber, ash chips and ash bark chips, and
- Firewood of any hardwood (deciduous) species.

Q4. What is the definition of firewood?

A4. Firewood means wood that is cut to lengths less than four feet long. This includes firewood cut for personal use.

Q5. What is a Compliance Agreement?

A5. A Compliance Agreement is a document that describes how a company will properly treat regulated articles to mitigate the spread of EAB and adhere to the quarantine law. A MDA representative is available to discuss Compliance Agreements in more detail at the request of any business or other entity involved in moving regulated articles. MDA can provide free training on EAB and also help determine how any business can lower the risk of spreading EAB with the least amount of disruption to business practices.

Q6. Do I need a Compliance Agreement?

A6. If you are moving regulated articles (e.g., ash material or hardwood firewood) out of a quarantine area you will need a Compliance Agreement. Ash material that originates from a non-quarantine county and transits the quarantine may require a Compliance Agreement, and it is recommended you contact MDA for further information.

Q7. How do I get a Compliance Agreement?

A7. You can contact the Arrest the Pest Hotline at 651-201-6684 in the Twin Cities or 888-545-6684 in greater Minnesota, or e-mail us at arrest.the.pest@state.mn.us and say you are interested in a Compliance Agreement for emerald ash borer. An MDA official will work with you to determine which Compliance Agreements, if any, are needed, explain the requirements, and work with you to implement any needed quarantine restrictions.

Q8. Why is all hardwood firewood regulated instead of only ash firewood?

A8. Once a log has been cut and split, it is extremely difficult to identify ash wood from other hardwood species. While this is especially true for the casual firewood user and homeowners, the experience of other EAB regulatory agencies across the nation have shown that the same has often applied to firewood businesses, too. Therefore, due to the potential risk associated with moving EAB-infested firewood, all hardwood firewood is regulated. There are no EAB quarantine restrictions on coniferous species of firewood, such as pine, spruce and fir.

Q9. Does the quarantine affect movement of hardwood (non-ash) nursery stock or hardwood (non-ash) wood products?

A9. In regards to EAB there are no restrictions on the intrastate movement of non-ash hardwood products such as nursery stock, logs, branches, green lumber or chips in Minnesota. However, the movement of all hardwood firewood out of quarantined counties is regulated.

Q10. Does the quarantine affect the movement of material within the quarantine areas?

A10. There are guidelines or best management practices for working with ash in known infested areas (PDF). There are no legal restrictions for the movement of regulated materials within the quarantine.

Q11. What can I do with my ash material from a quarantined county?

A11. There are multiple options available:

- Ash material can be brought to a disposal site within the quarantine. Download a list of known tree waste disposal sites (PDF).
- Material can be utilized within the quarantine for any legal purpose.

**If removing ash material or other regulated articles from the quarantine, the following options may be used but require a Compliance Agreement with MDA and / or USDA. We advise that this Compliance Agreement be in place before beginning processing operations. **

- Material can be chipped to 1 inch or less in two dimensions (two of three measurements-length, width and thickness-must be 1" or smaller).
- Material can be debarked, which means complete bark removal plus ½ inch of wood.
- Material can be composted; material must reach at least 140 degrees Fahrenheit for four days and the pile must be turned after four days.
- Material can be heat treated; the center of the wood must reach at least 160 degrees Fahrenheit for 75 minutes.
- Material can be kiln dried; must meet USDA guidelines.
- Material can be fumigated by a licensed fumigator.
- Material can be transported to an approved facility during the period of September 1 to April 30.

Q12. If I sign a Compliance Agreement, will I be required to keep records?

A12. Yes. If your company ships regulated articles under a compliance agreement or with MDA certification, you will need to maintain those shipping and/or certification records for 36 months, unless otherwise specified.

Q13. Do I have to keep records of shipments or treatments that do not involve regulated articles?

A13. MDA does not require records for treatment or shipment of non- regulated articles.

Q14. Can I bring firewood from a non-quarantined area into a quarantined area?

A14. There are no legal restrictions on firewood that originates from a non-quarantined county. At this time only Ramsey, Hennepin and Houston counties in Minnesota are quarantined. Firewood is allowed to come into those counties from a non-quarantined county. Once the firewood enters into a quarantined area, it becomes a regulated article.

Q15. If I have further questions about EAB or compliance agreements, or if I think I have found EAB, who do I contact?

A15. The Arrest the Pest Hotline is available for a wide variety of questions related to emerald ash borer. Contact us at the Arrest The Pest Hotline at 651-201-6684 (Metro Area), 888-545-6684 (Greater Minnesota), or arrest.the.pest@state.mn.us.

Credit to: Minnesota Department of Agriculture

Appendix C

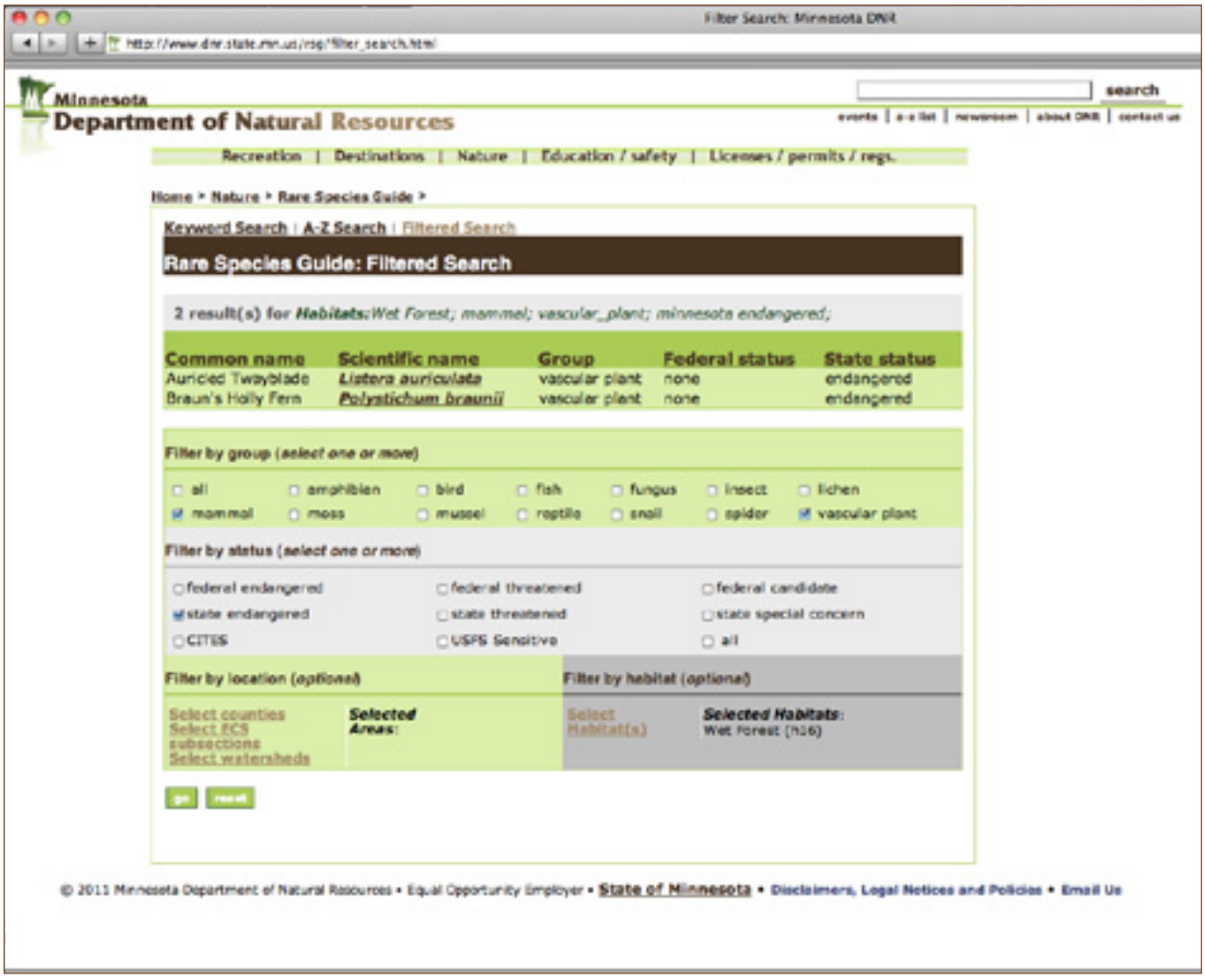
Minnesota Department of Natural Resources Rare Species Guide

You may search for rare plant, mammal, reptile, bird, and amphibian species potentially found in the Wet Forest, Floodplain Forest, Mesic Hardwood, Forested Rich Peatland, and/or Fire Dependent system plant communities by going to the Minnesota of Department of Natural Resources Rare Species Guide. http://www.dnr.state.mn.us/rsg/index.html

A "Filtered Search" allows you to search for rare species by habitat. You can choose to limit your search results by:
- species groups (e.g., just plants);
- status (endangered, threatened, special concern);
- county;
- Ecosystem Classification Subsection; and/or
- watershed.

Once you generate your species list, click on individual names to link to species' profiles. Profiles includes photographs, range maps, phenology information, and text.

Shown is the result of a sample search for rare, threatened and/or endangered mammals and vascular plants in the Wet Forest System.



Appendix D

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GLOSSARY

abiotic: *Nonliving parts of an ecosystem, such as soil particles, bedrock, air, water. See "biotic."*

adventitious: *Pertaining to a plant part that develops outside the usual order position or tissue — e.g., an adventitious bud arises from any part of a stem, leaf, or root but lacks vascular connection with the pith; an ad- ventitious root arises from parts of the plant other than a preexisting root, e.g., from a stem or leaf.*

anoxia: *Meaning lack of oxygen.*

Best Management Practices: *BMPs are practical guidelines aimed at lessening non-point source pollution from forest management activities such as road construction, skid trails and log landings.*

biomass: *Harvesting the wood product obtained (usually) from in-woods chipping of all or some portion of trees including limbs, tops, and unmerchantable stems, usually for energy production.*

biotic: *Pertaining to living organisms and their ecological and physiological relations.*

bole: *The trunk or main stem of a tree.*

BTU: *British Thermal Unit, is a basic measure of thermal (heat) energy. One BTU is the amount of energy needed to heat one pound of water one degree Fahrenheit.*

burl: *An abnormal growth of woody tissue protruding outward from a tree stem or trunk.*

calcareous: *An adjective used in a wide variety of scientific disciplines, referring to the deposit of calcium carbonate or lime. In some cases it may refer to a layer of sediment or sedimentary rock, a limestone deposit. Calcareous soils are relatively alkaline, in other words they have a high pH. This is because of the very weak acidity of carbonic acid. Note that this is not the only reason for a high soil pH.*

canopy: *The foliage cover in a forest stand consisting of one or several layers.*

cavity: *Holes in trees sometimes used for nesting and reproduction by wildlife species, most frequently birds or small mammals.*

character wood: *Wood prized by artists or craftsman because of its unique or distinctive grain patterns or form. Examples of character wood include burls, crotch wood.*

co-dominant: *Defines trees with crowns forming the general level of the main canopy in even-aged groups of trees, receiving full light from above and comparatively little light from the sides.*

conifer: *A cone-bearing tree (e.g. pines, firs, spruce, cedars, redwoods, larches etc.).*

crown dieback: *Decline of the branches and limbs in the canopy of a tree sometimes used as an indicator of tree health.*

deciduous: *Perennial plants that are normally more or less leafless for some time during the year.*

diameter at breast height (dbh): *The diameter of the stem of a tree measured at breast height (4.5 ft or 1.37 m) from the ground. On sloping ground the measure is taken from the uphill side.*

dieback/decline: *The progressive dying from the extremity of any part of a tree.*

dominant trees: *An individual or species of the upper layer of the canopy.*

duff: *The partially decomposed organic material of the forest floor beneath the litter of freshly fallen twigs, needles, and leaves.*

early succession: *The process by which one plant community is gradually replaced by another plant community. This may happen 'early' in the process or 'late;' thus the terms "early succession" and "late succession" are used to describe this process.*

ephemerals: *Ephemeral plants are marked by short life cycles, usually 6-8 weeks. Ephemeral means transitory or quickly fading.*

epicormic branching: *A shoot arising spontaneously from an adventitious or dormant bud on the stem or branch of a woody plant often following exposure to increased light levels or fire.*

floodplain: *The level or nearly level land with alluvial soils on either or both sides of a stream or river that is subject to overflow flooding during periods of high water.*

hydrology*: The study of the movement, distribution, and quality of water on Earth and other planets, including the hydrologic cycle, water resources and environmental watershed sustainability.*

hydrophobic: *Having little or no affinity for water molecules.*

incised streams: *Slopes along a creek, stream or river are eroded in a downward fashion.*

leaf flush: *The time in the season during which leaves appear on a tree.*

mesic: *Sites or habitats characterized by intermediate moisture conditions.*

microsite: *A small part of an ecosystem that differs markedly from its immediate surroundings.*

monotypic: *Referring to conservation biology and successional changes leading to a single species.*

morphology: *The external and internal form and structure of whole plants, organs, tissues, or cells.*

native plant community: *A group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes that tend to repeat over space and time. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes.*

oriented strand board: *Also known as OSB or waferboard, is an engineered wood product formed by layering strands (flakes) of wood in specific orientations.*

paleoscientist: *Scientists who study organisms of the past.*

peat/peatlands: *Organic soil material that originates from plants.*

phloem: *A layer of cells just inside the bark of plants that conducts food from the leaves to the stem and roots.*

punky: *Soft, crumbly decayed wood that has been attacked by fungus, sometimes used as tinder.*

pure stands: *Forest, crop, or stand composed principally of one species, conventionally at least 80 percent based on numbers, basal areas, or volume.*

quarantine: *A temporary rule intended to help prevent a potentially dangerous or destructive pest or disease organism from spreading outside a known infested area. In the case of the emerald ash borer (EAB), quarantines are designed to limit the movement of potentially infested firewood or other materials such as live ash trees that might harbor EAB larvae.*

riverine: *All wetlands and deep water habitats contained within a natural or artificial channel that periodically or continuously contains moving water, or that forms a link between two bodies of standing water.*

select harvest: *A cutting that removes only a portion of trees in a stand.*

serpentine trails: *Trails that wind and twist, like a snake.*

shade tolerant: *Having the capacity to compete for survival under shaded conditions.*

snag: *A standing, generally unmerchantable dead tree from which the leaves and most of the branches have fallen.*

sprouts: *Shoots arising from the base or sides of a woody plant.*

windthrow: *A tree or trees felled or broken off by wind. Also called "blowdown."*

Preparing for Emerald Ash Borer

A Landowner's Guide to Managing Ash Forests

Martin Streit, Taylor Scarr, & Lynn Farintosh
Ontario Ministry of Natural Resources
October 2012

Introduction

The inevitable arrival of the emerald ash borer (EAB) presents a daunting challenge for many of Ontario's woodlot owners. This factsheet describes the ash forests of Ontario and discusses the emerald ash borer. Recommendations are provided to help landowners diversify their ash forests prior to an EAB infestation in order to lessen the impact of the insect.

Ash in Ontario

White ash, bark has deep furrows

There are five native species of ash in Ontario. They are: white ash (Fraxinus americana), black ash (Fraxinus nigra), green ash (Fraxinus pennsylvanica - also called red ash), pumpkin ash (Fraxinus profunda) and blue ash (Fraxinus quadrangulata). By far the three most common species are white, black and green ash. In Ontario, pumpkin ash and blue ash are uncommon and are found only in the southwestern part of the province. Woodland owners in these areas should note that blue ash seems to be showing a higher level of resistance to EAB attacks and therefore should receive greater priority for retention in management programs (see page 11 for further information).

Black ash, bark is loose, flaky

Ash species are mid-tolerant of shade and are most often found in early to mid successional forests or where gaps occur in mature forests (see page three for further information). White ash is the most common native ash in Ontario. It grows throughout most of the Deciduous Region and the Great Lakes-St. Lawrence Forest Region, but usually occurs as a minor component in upland hardwood forests (i.e., sugar maple and red oak). White ash grows best on deep, moist, well-drained soils (Farrar, 1995 and Burns et al., 1990).

Green ash, bark has shallow furrows

Even-aged red oak forest with white ash component, Lanark County

Black ash grows in swampy areas and in riparian zones (streamsides and shorelines) throughout Ontario and ranges from the southern-most portions of Ontario up into the boreal forest in the north (Farrar, 1995). Black ash will commonly grow in southern Ontario forests that include species such as red maple, silver maple, white elm, yellow birch, white cedar and spruce.

Richard David, black ash basket maker from Akwesasne (Photo: C Craig)

Green ash is the predominant ash species growing south of the Canadian Shield. It grows throughout the Great Lakes-St. Lawrence Forest Region, often in riparian areas. Green ash can also be found in upland sites if the competition is not too great (Burns et al., 1990). It is commonly found growing in fencerows and regenerating under established tree plantations in southern Ontario. Green ash can also seed into abandoned farmland and form nearly pure stands.

Even-aged green ash and soft maple lowland forest, Dundas County

Green ash is often used as an ornamental tree on city streets and in parks (Farrar, 1995).

Green ash and white ash wood products are marketed together. Both woods are valued for their durability and are used for flooring, sporting goods, tools and furniture. Black ash is used to make baskets which are an important cultural and economic component of some First Nations communities. Ash species are also locally important as firewood. Healthy ash trees are fast-growing and, if managed properly, can appreciate substantially in size and log grade as shown in the example below.

Years since first management	Diameter		Volume		Log grade
	(in)	(cm)	(fbm)	(m^3)	
1	12	30.5	68	0.299	3
10	15	38.1	140	0.616	2-3
20	18	45.7	259	1.14	2
30	21	53.3	430	1.892	1-2

Thirty year growth of a green ash tree in a managed forest (Streit, 2011)

Ash in Southern Ontario

The red line on the map on this page defines the southern boundary of the Canadian Shield, the part of Ontario underlain by Precambrian bedrock. On the Canadian Shield, ash is typically a minor component of the forest. The percentage of ash species in the forest tends to be much higher south of the Canadian Shield. In these areas, most land was cleared for agriculture in the late 1800s and early 1900s. Forest cover in many parts of southern Ontario was practically non-existent at that time. Over the years, many of the poorer quality fields were abandoned, allowing tree species to re-establish. Old field sites were often recolonized by pioneer tree species such as green ash, red maple, silver maple, white elm, poplar and cedar. Forests like these are called early successional forests. They are in transition from a disturbed landscape and will eventually evolve into forests with different tree species which are more adapted to a shady, closed-canopy environment.

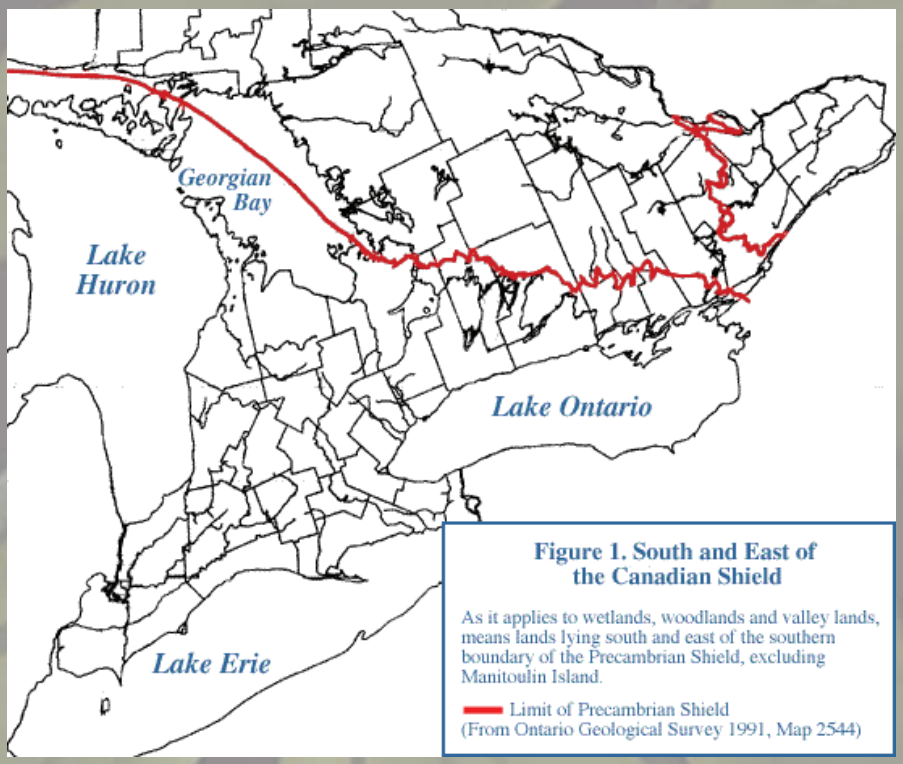
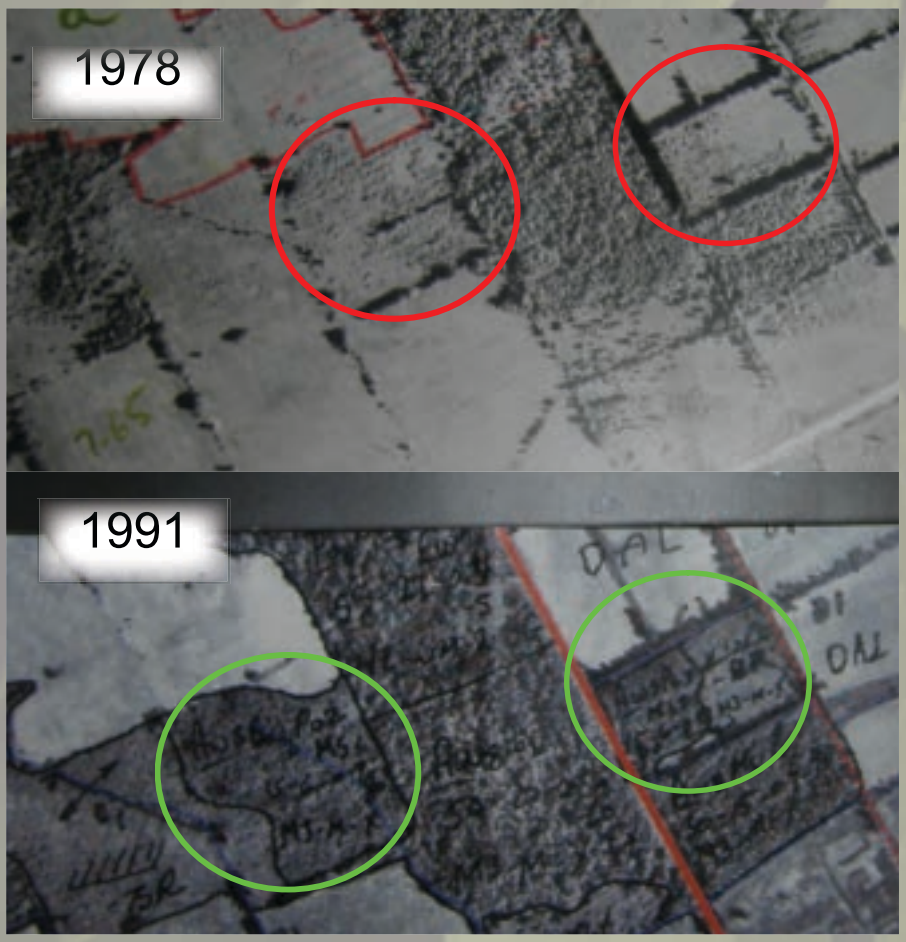


Figure 1. South and East of the Canadian Shield

As it applies to wetlands, woodlands and valley lands, means lands lying south and east of the southern boundary of the Precambrian Shield, excluding Manitoulin Island.

Limit of Precambrian Shield
(From Ontario Geological Survey 1991, Map 2544)



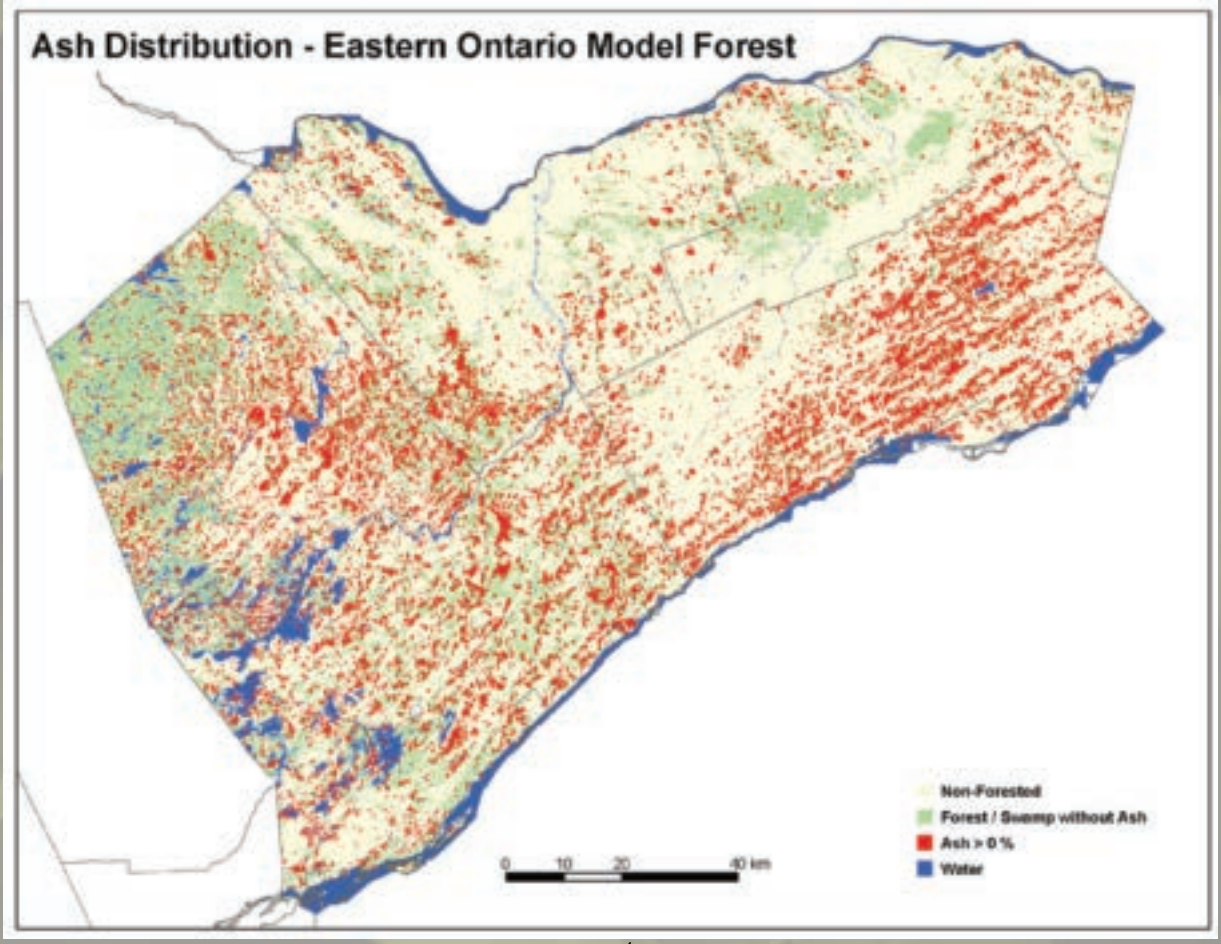
Colonization of abandoned fields over a 13 year period by green ash-soft maple-white elm-poplar forest in Dundas County

If you look in the understory of an ash-dominated forest you may already see a diversity of other tree species present as regeneration. The most common species that regenerate in ash-dominated forests on imperfect to poorly drained lowland sites include red maple, white elm, bur oak and shagbark hickory. Species such as sugar maple, basswood, bitternut hickory and ironwood will regenerate

on better drained upland sites. Regeneration of conifer species such as hemlock, white spruce and white pine is less common, but these species were more abundant on these sites at one time.

Early-successional green ash-white elm forest

The distribution of ash forests in a partially disturbed landscape can be extensive. For example, the Eastern Ontario Model Forest has mapped the extent of ash forests within its boundaries (shown in red on the map below). There are 215,000 hectares of forest with ash present, including 70,000 hectares of early successional forests dominated by ash within this area. This inventory does not include the substantial amount of ash found in fencerows, riparian areas, regenerating in the understory of other forests and plantations, or along municipal roadways.



The Emerald Ash Borer

The following is a brief summary of information regarding the emerald ash borer. For more information, there are a number of references listed at the back of this publication.

EAB adult and larva (Photo: Taylor Scarr, OMNR)

The emerald ash borer (Agrilus planipennis Fairmaire) is an invasive exotic beetle from China and other parts of Asia. It was first discovered in North America in 2002 in the Detroit area of Michigan and the Windsor area of Ontario. This insect has now spread to most of south western Ontario, with infestations from Oshawa west to Sarnia and Windsor. Separate infestations exist in Sault Ste. Marie and in the Ottawa area. Infestations also exist in Quebec in the Gatineau area and in and around Montreal.

The beetle attacks and kills all native species of ash, and is estimated to have killed as many as 100 million ash trees in southern Ontario, Michigan and surrounding states. It poses a major economic and environmental threat to urban and forested areas. The beetle has continued to spread despite some initial control efforts and on-going federal regulatory restrictions on the movement of ash material, ash trees, and firewood. Some of this spread has been through natural dispersal, with the insect capable of flying several kilometres per year. Long distance spread of the insect has mostly resulted from people moving infested firewood, logs, or nursery stock. In known EAB-infested areas, the Canadian Food Inspection Agency (CFIA) designates regulated areas, which restricts the movement of wood material.

Adult beetles emerge through the bark of ash trees in June to August. After emergence the adults feed on the margins of the leaves of ash trees. Although this can be a good indication of the presence of emerald ash borer, it has negligible impact on tree health. The beetles then mate and the females lay eggs in bark crevices on the trunk and branches. The larvae emerge in about ten days and tunnel into the bark to the cambial layers where they begin to feed in meandering S-shaped galleries. This feeding under the bark kills the tree by cutting off the flow of nutrients and water. The larvae overwinter under the bark and pupate, with the adults emerging a few weeks later to start the cycle again (NR Can, 2012).

D-shaped exit holes (Photo: Ed Czerwinski, OMNR)

Symptoms of an attack by the EAB are often very similar to other causes of tree decline. In fact, in many areas of Ontario ash have been showing signs of decline and general poor health for many years, primarily due to environmental stresses such as drought. To identify a tree under attack from the EAB look for 7 to 10 centimetre bark cracks on young trees, larval galleries under the bark of any trees that have been attacked in the last year or two, and tiny D-shaped adult

Ash mortality caused by emerald ash borer in the riparian zone along the Canard River (Photo: Ed Czerwinski, OMNR)

exit holes (4-5 mm wide) anywhere on the trunk or roots. Increased woodpecker activity is also a good indicator of EAB. An ash tree under attack may have dieback in the top half of the crown in the first year, followed by epicormic branching (new green shoots) along the bole. Foliage may turn yellow or wilt during the growing season.

The adults are metallic green, narrow in shape, and 8.5-13.5 mm long. The antennae are short and thin. Larvae are slender, creamy white, and flattened with a brown head on one end a pair of brown pincers at the other end.

In all cases, keep an eye out for signs of decline. See de Groot et al. 2006 for details on identifying EAB signs or symptoms.

If you think you have found EAB in your ash trees and you are in an area where the insect has not been previously reported, call the CFIA at:

1-866-463-6017

As emerald ash borer has moved into new areas in southern Ontario, it has killed approximately 99% of the ash trees. Ash trees of all sizes are vulnerable to attack. Blue ash is one exception, and shows some resistance similar to that of ash species in the insect's native range in China. While trees in woodlots are killed by the beetle, impacts in large contiguous forests are not yet known as the insect has not yet invaded these areas.

The insecticide TreeAzin™, derived from the neem tree of India, has been proven effective at controlling emerald ash borer (BioForest, 2012). Because it needs to be injected into the tree, it is used mostly to protect urban or ornamental trees. Research is on-going into long term controls that may eventually reduce the impact of the beetle. These projects include the use of native or imported parasites that attack the eggs or larvae, fungi that kill the adults, and breeding trees for resistance to attack.

Although visual surveys can find beetle infestations, by the time signs or symptoms of attack are visible the insect has been in the trees for at least 3-4 years. Plastic prism-shaped traps are used across the landscape to detect new infestations. The traps are baited with a lure derived from the volatiles produced by green leaves, and with a recently discovered pheromone produced by the females to attract the males. Branch sampling (Ryall et al. 2011) is being used to detect new infestations and to determine the severity and the boundaries of infestations.

Planning Ahead: Recommended Approaches to Managing Ash Forests

In the face of this destructive pest, many landowners with ash forests are left wondering what they can do to reduce the impact. If your ash forest is infested with EAB or located near a known infestation, you should seek expert advice specific to your local situation. Such advice is likely available from a forestry consultant, a member of the Ontario Professional Foresters Association (http://www.opfa.ca/consultants/consultants.php), or from staff of the local conservation authority, woodlot association, community forest or Ontario Ministry of Natural Resources (OMNR) office. Williams and Schwan (2011) provides guidelines and example prescriptions for use in these situations.

If your ash forest is further away from an EAB infestation, then you still have time to diversify your forest to lessen the eventual impact of this insect. The following sections of this factsheet provide recommended activities that a trained and experienced landowner can carry out. However, if the scale of operations is beyond your level of comfort or expertise then a skilled logger should be hired to do the work. It is also recommended that you seek advice from a forestry professional and have the trees to be harvested marked for removal by a tree marker certified by the OMNR according to these recommendations.

To reduce the spread of invasive pests, try to buy and sell your wood locally.

Please check the CFIA website to locate the current boundaries of regulated areas and associated legal restrictions on wood movement.

http://www.inspection.gc.ca/english/plaveg/pestrava/agrpla/regrestrice.shtml
http://www.inspection.gc.ca/english/plaveg/pestrava/agrpla/regmate.shtml

Enhancing Tree Species Diversity in the Woodlot

Increasing tree species diversity in your woodlot can help to mitigate the impact of the EAB threat. When EAB arrives the death of the ash trees will create very open conditions in ash-dominated forests. If large saplings of other tree species are present in the forest understory (advanced regeneration), they will respond to the increase in light conditions and dominate the new forest. However if advanced regeneration is small or sparsely distributed, there is a significant risk that light-loving species like raspberry and opportunistic species like buckthorn and other invasive plants will take over.

Woodlot owners can use good forestry practices to control the timing and size of canopy openings and the selection of trees to remain to encourage the regeneration and growth of tree species other than ash. Seven recommendations are provided below to help diversify your ash forest and better withstand an outbreak of emerald ash borer.

1) Thin the stand to reduce the ash component:

Carry out a low intensity thinning of ash forests to reduce the overall percentage of ash in the overstory. This thinning will also create the ideal light conditions in the understory for the regeneration and growth of other more shade tolerant tree species such as bur oak which are adapted to growing in small canopy openings. Ash flourishes in more open conditions present in large canopy openings. Depending upon the proximity of the infestation, landowners will have time to make one or more additional harvest cuts in the future.

Be careful to avoid over cutting ash-dominated stands, which may lead to:

- a proliferation of ash regeneration,
- an increase in undesirable or exotic species, such as buckthorn,
- a conversion to non-forest cover and/or,
- elevated water tables with increased risk of windthrow.

Raised water table and enhanced competing vegetation 20 years after over-harvest of a lowland hardwood forest

Lightly thinned green ash and soft maple stand with bur oak advanced regeneration. (Photo: D Hamilton)

2) Remove defective or diseased trees:

Trees to be removed in thinning operations are those with obvious disease or defects (unacceptable growing stock, or UGS). Trees to be retained are healthy, well-formed individuals (acceptable growing stock, or AGS). A complete description of tree classification and defects with colour pictures can be found in the Ontario Tree Marking Guide (Ontario Government, 2004).

Retain AGS trees of all tree species including ash and non-traditional species such as poplar, consistent with the residual stocking guidelines provided in recommendation number 3.

Tree removal should be carried out in all diameter classes, not just large trees.

UGS green ash marked for removal

3) Follow residual stocking guidelines:

For landowners familiar with silvicultural prescriptions, the following residual stocking guidelines should be used. (Detailed information on silvicultural prescriptions is provided in the Ontario Tree Marking Guide (Ontario Government, 2004))

A) Selection management:

If the ash content is less than 30% remove 33% of the pre-harvest basal area of all tree species. If the ash content is greater than 30%, remove 25% to 30% of the pre-harvest basal area. As seen in the picture below, the goal is to reduce the percentage of ash, but not to eliminate all ash trees.

B) Uniform shelterwood management:

In even-aged stands, the target canopy closure should be 70%. Marking will focus on thinning smaller diameter trees, although non-ash species which are developing in the understory should be considered for retention as part of the next forest. In an ash-dominated forest ash trees will still make up the majority of the canopy.

UGS ash marked for removal. AGS soft maple and ash retained (1/3 basal area removal)

Example of ideal 70% crown closure to encourage non-ash species; note the elm (upper left) has lost its leaves, but is healthy

4) Promote regeneration of non-ash tree species:

Where available, retain AGS non-ash tree species as a seed source for regeneration. In an ash-dominated lowland stand, priority species for retention include red maple, silver maple, bur oak, shagbark hickory, yellow birch, white pine, white cedar and white spruce. On better drained soils, sugar maple, red oak, beech, black cherry, bitternut hickory, basswood, white pine and hemlock are favoured as seed trees. Other less shade-tolerant minor species (e.g., butternut) may also occur sporadically in the forest. Remove competing UGS stems in areas where regeneration of these species is present, particularly where seedlings are greater than one metre in height.

If seed trees are limited or absent, planting of these species should be considered underneath canopy openings. There is a variety of suitable native tree species available at your local tree nursery. The selection of the species should be based upon the soil type (texture, depth and drainage). The nursery will be able

Natural white pine and red maple regeneration under lowland ash and red maple forests

to provide you with advice on the species to plant. Also, when planting tree seedlings the competition must be controlled in the first few years to ensure success.

5) Retain non-ash species as crop trees:

When comparing trees of similar quality for removal favour retention of non-ash species such as shagbark hickory, which is shown in the photograph below.

6) Conserve forest values:

Maintain and protect wildlife trees and other forest values including cavity and mast trees, isolated conifers, stick nests, riparian areas and species-at-risk and their habitat (see the Ontario Tree Marking Guide (Ontario Government, 2004)).

Cavity in green ash growing within protected riparian area

Green ash and shagbark hickory forest, Dundas County

AGS white elm

7) Consider retaining elm:

White elm trees are common in younger ash stands. Although prone to Dutch elm disease (and eventual mortality) AGS elm trees are candidates for retention. Isolated individual elms may prove to be resistant or tolerant to the disease. Even if they are not resistant, retained elms are prolific seed producers. Elms as young as 15 years of age may provide seed for future generations of elm trees (Burns et al, 1990).

In order of priority, tree species to retain should be AGS:

1. Other species and wildlife trees suited to the site

2. Elm species

3. Ash species (especially blue ash where present).

Enhancing Diversity in Linear Forests (Windbreaks and Riparian Buffers)

In rural and urban areas of southern Ontario, green ash and white elm are two of the most common tree species found in linear forests: windbreaks and forests that border waterways (riparian buffers). Windbreaks reduce soil erosion, increase crop yield and protect livestock. They shield buildings and help reduce heating costs. Windbreaks can also add beauty to landscapes and provide habitat for wildlife (Ontario Government, 1995). Riparian buffers shelter streams from the sun, which helps modify water temperature for fish species, slow rates of runoff and soil erosion into streams and provide wildlife habitat and travel corridors.

Sadly, local residents are accustomed to the regular death of elm trees killed by Dutch elm disease. Linear forests are now at further risk of attack from the emerald ash borer. Landowners who wish to maintain cover in their ash-dominated windbreaks and riparian buffers need to take decisive action in advance of the potential attack of the emerald ash borer.

1) Maintain other tree species

The best method to maintain a windbreak or riparian buffer is to foster the growth of diverse tree species. Healthy specimens of all species should be retained as seed sources and to create an environment for other tree species and shrubs to regenerate and grow. Small animals and birds such as squirrels and blue jays collect seed from trees such as oak, hickory, basswood, and butternut and distribute them as they move along the travel corridors. It is not uncommon to find seedlings of these trees in the understory of windbreaks and riparian areas hundreds of metres from the source of the seed.

Green ash windbreak, Morrisburg, Ontario.

Bur oak natural regeneration

2) Consider underplanting other tree species

White spruce and white pine planted under green ash windbreak, Morrisburg, Ontario

If your linear forest is composed primarily of ash or elm trees, and if there is limited regeneration of other tree species, then the linear forest can be diversified by establishing trees through planting before emerald ash borer arrives. When choosing a tree species to plant, consider the soil type (soil texture, depth and drainage) and the orientation of the linear forest. South and west-facing aspects experience more light penetration, allowing the landowner to plant tree species which require more light. Dense shaded areas and north and east aspects require species that tolerate more shade. Due to their shape, linear forests are susceptible to invasive trees and plants (eg buckthorn). Removal of invasives may be necessary prior to tree planting. More information on windbreaks can be found in the extension note listed in the references.

Landowner with planted hemlock seedling in a well- shaded windbreak

In Summary

Good forestry practices mean landowners shouldn't wait for the insect to arrive before taking steps to reduce its impact. The emerald ash borer infestation is a dynamic situation. The recommendations provided in this factsheet may change over time as we learn more about the spread and impact of this invasive insect. It is up to all of us to keep informed and up-to-date on this potentially devastating infestation.

EAB On-Line Resources

Check out the MNR's Forest Health Management webpage at http://www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/STEL02_166920.html for information on and photos of emerald ash borer and other forest health issues.

The Canadian Food Inspection Agency website has links to news releases about the latest distribution of emerald ash borer and other invasive species. Photos are also provided. Visit http://www.inspection.gc.ca/english/plaveg/pestrava/agrpla/agrp- lae.shtml

An international Canada/US website with the latest information on the EAB is at http://emeraldashborer.info/index.cfm

The south-central Regional Forest Health Update at http://www.foca.on.ca/xinha/plugins/ExtendedFileManager/demo_images/Forest_Health_Update_June_2010.pdf has information, starting on page five, on EAB surveys being conducted in Ontario.

The Wisconsin Department of Natural Resources website has information on many aspects of emerald ash borer, including symptoms and signs of the insect, and how to identify other ash tree pests http://datcpservices.wisconsin.gov/eab/index.jsp

The State of Minnesota has a detailed publication for landowners available on-line http://www.myminnesotawoods.umn.edu/wp-content/uploads/2011/07/103817-Ash-Booklet-5.pdf

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Photography Credits

Cover Photo: Bur oak and shagbark hickory advanced regeneration under a thinned green ash-soft maple stand.

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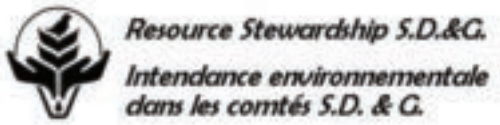

Signs and Symptoms of EAB Infestation

SIGNS

D-shaped emergence holes: Adult EAB emerge from under the bark and create a D-shaped hole measuring about ⅛ inch in diameter.

S-shaped larval galleries: EAB larvae wind back and forth as they feed under the bark of an infected tree. This feeding pattern creates s-shaped larval galleries packed with sawdust.

Larvae: EAB larvae are cream-colored flatworms that have pincher-like appendages at the end of their abdomen. Mature larvae reach 1½ inches in length.

Adults: Adult EAB beetles are metallic green in color and are ⅜-½ inches long. Adults have flat stomachs and round backs.

SYMPTOMS

Crown dieback: EAB causes dieback of the upper and outer tree crown. Trees begin to show dead branches and leaves throughout the canopy, beginning at the top. Foliage at the top of the tree is thin and discolored.

Sprouting: EAB often causes epicormic sprouting at the base and/or on the main stem of the infected tree. Infected trees often begin to sprout new shoots just below where the larvae are feeding.

Bark splits: Infected ash trees often develop callus tissue where EAB larvae are feeding. The callus tissue causes the bark to form vertical splits or fissures. Larval galleries can often be seen beneath the bark splits.

Woodpecker feeding: Woodpeckers frequently feed on EAB larvae located under the bark of infected ash trees. Woodpeckers are typically seen feeding high in the crown where EAB infestation begins.

What you can do to minimize the devastating effects the EAB is having on American Indian traditions and forests.

- Teach your children about your traditions
- Watch for signs and symptoms of EAB
- Report suspected infestations to tribal, state, or federal natural resource managers and tribal leaders
- Collect and store ash seeds with your tribe
- Don't move firewood
- Work with your tribe to develop a comprehensive EAB and invasive species management plan

Identifying Ash Trees

Ridged Bark: On mature trees, the bark is tight with diamond-shaped ridges. On young trees, the bark is smooth.

Compound, Opposite Leaves: A leaf has 5 to 11 leaflets with either smooth or toothed margins. Leaflets are opposite with one at the top.

Seeds: When present, seeds usually hang in clusters and are dry and shaped like oars.

Opposite Branches: Branches and buds are directly across from each other rather than staggered.

For more information about emerald ash borer, visit:

www.emeraldashborer.info
www.sustainabledevelopmentinstitute.org
www.na.fs.fed.us/fhp/eab
www.nrs.fs.fed.us/disturbance/invasive_species/eab/
www.emeraldashborer.wi.gov
www.blackash.org

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Emerald Ash Borer Impacts on American Indian Communities

Emerald Ash Borer Threatens American Indian Traditions

Emerald ash borer (EAB) infestation is a major concern for American Indian people. Many American Indian cultures and traditions rely on ash trees for the wood needed for making baskets, lacrosse sticks, pipe stems, flutes, and medicinal remedies. The ash tree is a central figure in some traditional and religious stories told by several American Indian tribes.

The emerald ash borer is an invasive insect that is striking at the core of many American Indian traditions and cultures. Will these traditions be something that American Indian children will only be able to read about in books? Will their knowledge of ash trees and basket making be limited some day to story telling? Or can something be done to prevent the loss of ash trees to this insect? The EAB has already had devastating impacts on ash trees on several American Indian reservations in the Midwest, and it will likely affect all communities, forests, and reservations where ash trees are found.

TRADITIONAL BASKET WEAVING: Dozens of American Indian tribes and cultural groups, including the Abnaki, Ojibwa, Malecite, Mezkwaki, Potawatomi, Penobscot, Mohawk, and others, use black ash trees to make baskets. EAB infestations are making it more difficult for basket weavers to find healthy, basket-quality trees. The scarcity of trees, combined with the fact that fewer people are making baskets, threatens this centuries-old cultural and economic tradition.

PIPES AND FLUTES: American Indian pipe stems and flutes are carved from many kinds of trees, including black ash. Pipes are often used for ceremonies and special events. American Indian pipe stem carvers craft some of their most beautiful pipe stems from black ash trees. EAB threatens this tradition by decreasing the availability of ash trees that can be used for pipe stems.

MEDICINAL REMEDIES: American Indian tribes in the Eastern United States use different parts of ash trees to make medicinal cures for various maladies. Some tribes use ash sap to treat external skin growths. Other tribes value an extract of ash leaves as an antiseptic for use after childbirth. Some tribes use a tea made from ash bark to treat itching scalp and sores. Ash seeds have been used as an aphrodisiac, a diuretic, an appetite stimulant, and a remedy for fevers. EAB threatens the availability of these traditional medicines and any new medicinal discoveries that may come from ash trees in the future.

LACROSSE: Lacrosse games are ceremonial in origin and bring tribes and families together. Today, lacrosse is played by thousands of people around the world. Traditional lacrosse sticks are crafted from ash wood, making ash trees an irreplaceable component of American Indian lacrosse sticks.

What is Emerald Ash Borer?

Emerald ash borer (EAB), *Agrilus planipennis*, is an exotic beetle that was discovered in southeastern Michigan near Detroit in the summer of 2002. EAB probably arrived in the United States on solid wood packing materials carried in cargo ships or airplanes originating in its native Asia.

Since it was first discovered, this insect has been found in Ontario, Ohio, Indiana, Maryland, Illinois, Pennsylvania, West Virginia, Wisconsin, Missouri, Virginia, Minnesota, and New York.

How Does the Emerald Ash Borer Affect Ash Trees?

The adult beetles feed on ash foliage but cause little damage. The larvae, however, tunnel under the bark of an ash tree and feed on the inner bark, disrupting the flow of water and nutrients between the tree's roots and crown.

EAB larval feeding makes the tree's crown thinner and the branches die back, and eventually causes the tree to die. EAB larvae can usually kill ash trees within 2 to 4 years, but a heavy infestation could kill a tree in as little as one year.

EAB is known to infest all ash species, including green ash (*Fraxinus pennsylvanica*), white ash (*F. americana*), black ash (*F. nigra*), blue ash (*F. quadrangulata*), and all horticultural cultivars of these species. EAB has killed over 20 million ash trees throughout North America since its discovery.

How does EAB Spread?

EAB moves short distances by flying and longer distances by hitching a ride in infested ash trees or ash wood products that are moved by people. Adults don't fly far from where they emerge, depending on the availability of food (ash trees). EAB is most commonly spread long distances by people moving infested firewood, nursery stock, or ash logs.