



ASH MANAGEMENT: EMERALD ASH BORER

**Michigan Department of Natural Resources
Forest Resources Division**

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TABLE OF CONTENTS

REDUCING STAND VULNERABILITY TO EMERALD ASH BORER	1
GENERAL GUIDANCE FOR REDUCING STAND VULNERABILITY TO EAB IMPACT	2
TIMBER SALE CONTRACT GUIDELINES (CURRENT AS OF 09/23/10)	3
APPENDIX A: THE EMERALD ASH BORER	5
APPENDIX B: ASH CONTAINING TIMBER SALES AND THE EAB QUARANTINE.....	6
APPENDIX C: ASH DISTRIBUTION MAP FROM USDA FOREST SERVICE, FOREST INVENTORY & ANALYSIS DATA POINTS	7
APPENDIX D: MICHIGAN’S ASH RESOURCE VALUES IN BRIEF	8
APPENDIX E: STATE FOREST LAND INVENTORY WITH IDENTIFIED ASH COMPONENTS*	10
APPENDIX F: ASH SILVICULTURE NOTES & EXCERPTS FROM SILVICS OF N. AMERICA: VOL. 2 HARDWOODS.....	12
APPENDIX G: ASH PHLOEM MODEL: RELATING TREE SIZE TO EAB POPULATION POTENTIAL.	15
APPENDIX H: EDUCATION & OUTREACH.....	16
APPENDIX I: MDA REGULATORY ACTIVITY ON STATE LANDS	18
APPENDIX J: ASH TREES, INDIGENOUS COMMUNITIES AND THE EMERALD ASH BORER.....	19

Reducing Stand Vulnerability to Emerald Ash Borer

As stewards of Michigan's ash resources, a goal is to reduce the vulnerability of our forest resources to the Emerald Ash Borer (EAB). The goal is not to eliminate ash from the forest, but to create a more diverse forest resource that is resistant to catastrophic changes affecting a single species or genera. Generally, the recommendation is to reduce the ash component of forest stands to a maximum 10% of total stand basal area, and to promote tree species diversity. Vigorous pole size and smaller ash should be targeted for retention. Removing one large ash has a much greater effect on reducing EAB population potential than does removing many saplings or a few pole size trees. The objective is to create a stand that will maintain a minimum or greater basal area, in the event that all ash is eventually lost to EAB.

Stands with high proportions of ash may require several harvest cycles to reduce the ash component to desired basal areas. This is possible, if given enough time before EAB begins impacting tree growth and survival. The EAB populations expand at an average rate of ½ mile per year. Thus, stands greater than 5 miles from EAB populations are projected to be about 10 years away from EAB impacts. Unfortunately, confidence in maps of EAB population locations is low. Knowledge of EAB outlier populations represent intensive survey efforts which no longer occur in the Lower Peninsula (LP). Additionally, effective survey tools for detecting low level populations are lacking. Our only survey tools, trap trees and panel traps, can be costly, labor intensive and only effective if EAB populations are near. Detecting new and undetected older EAB introductions in quarantined counties falls upon the Forest Health, Inventory and Monitoring Program and upon reports from trained resource professionals. This will produce detections and maps only of EAB impacted stands, not of low level EAB populations. Because of the difficulty of detecting EAB populations without tree symptoms, these guidelines will use a distance of 10 miles from known EAB populations to represent a 10 year pre-impact buffer.

Stands with high basal areas of ash present the greatest ash reduction challenges. In uplands, ash most often occurs in pockets within a stand such that 20 square feet of ash stand basal area is represented by several pockets of pure ash. Thus, reducing ash creates canopy gaps. Large canopy openings encourage both ash regeneration and recruitment. Where possible, canopy gaps should be less than 60 feet in diameter to discourage ash recruitment. Larger canopy gaps, however, cannot be avoided in stands with both a high proportion of ash and a close proximity to EAB populations. In such cases, active treatment of ash regeneration through cutting and/or herbicide application may be necessary to keep the ash component to an appropriate level and to encourage species diversity. Planting canopy openings may be necessary to attain the desired mix of tree species.

Lowland/wetland sites present unique management challenges. The value of the ash to affected watersheds and wildlife habitats, and treatment impacts on water quality (e.g. Best Management Practices) is considered when formulating a management response. Additionally, Native Americans have strong interests in the management and fate of black ash. Working with Native American tribes offers additional opportunities to utilize and manage this resource.

If both ash and American beech occur in a stand, the loss of beech from beech bark disease (BBD) should also be considered when calculating residual basal areas. The BBD spread rates are about 6 miles per year. Stands greater than 40 miles from known beech scale infestations have a 10 year pre-mortality buffer. (See American Beech Management: Beech Bark Disease-IC4165).

Removing low vigor and low quality ash may help to slow EAB population buildup and spread while improving overall stand productivity. If no vigorous ash occurs in a stand, the decision to leave a residual ash component will primarily depend on non-timber values and retention guidelines.

Three observations: 1) EAB attack does little to degrade the value of ash wood products in living trees; 2) Quickly detecting ash dieback related to EAB attack as symptoms first appear will greatly improve the opportunity to minimize losses of commercially valuable ash volume; and, 3) This guidance will improve as we monitor and better understand EAB biology, spread rates and tree impacts as affected by site quality, ash species, tree vigor, host abundance, and management practices.

General Guidance for Reducing Stand Vulnerability to EAB Impact

Currently, the entire Lower Peninsula has populations of EAB in nearly every county and maps showing each and every population are not possible, but an attempt will be made to identify major outbreaks for staff to make decisions on treating stands. The general assumption for the Lower Peninsula should be to treat stands with high ash densities as under immediate threat, unless good local knowledge suggests otherwise. The Upper Peninsula EAB populations are still geographically isolated and mapping will be used to aid staff in determining prescriptions more reliably.

1. Ash resources within 10 miles of EAB populations*. These stands are at high risk of EAB caused ash decline and mortality within 10 years. Reduce ash basal area, if ash comprises greater than 10% of total stand basal area. If the ash resource is of poor vigor, the risk of EAB caused decline and mortality is greater. Where ash resources are generally of poor vigor, retain a minimal or no ash component.
 - a. Ash trees in upland hardwoods. Generally, it is not advisable to reduce stand basal area below 70 square feet per acre. Remove the largest ash first, leaving vigorous pole sized trees (See Appendix H: MTU Ash Phloem Model: Relating Tree Size to EAB Population Potential.) Limit canopy gaps to 60 feet in diameter or less if possible.
 - b. Lowland or wetland ash resources. In lowland stands, management including salvage and pre-salvage may not be practical due to BMP concerns and/or low or absent commercial values. If a stand is in this situation, options include:
 - Allow EAB mortality to run its course.
 - Alter management to non-timber objectives.
 - Convert the stand to different tree species.
2. Ash resources > 10 miles of EAB populations*. These stands may have greater than 10 years before EAB arrives. Use conventional forest management practices to increase tree species diversity and decrease ash components, as outlined in Section 1 above. Ash reduction is a higher priority the nearer an ash resource is to EAB populations. (Note: Watch for newly discovered EAB populations established via artificial movement of firewood or other ash products which place stands < 10 miles for EAB populations.)

* Maps showing known EAB populations will be provided by the Forest Health, Inventory and Monitoring Program via the Forest Health listserv, annually published Forest Health Highlights (http://www.michigan.gov/mdard/0,4610,7-125-1568_2390_18298_33138---,00.html).

3. Tree species diversity and stand regeneration. The EAB mortality or ash pre-salvage/salvage harvests may lead to under-stocking, conversion to undesirable tree species and/or to areas of non-forest cover. This is especially true where American beech and ash comprise a significant proportion of the total stand basal area. In such cases, active treatment of ash regeneration through cutting and/or herbicide application may be necessary to keep the ash component to an appropriate level and to encourage tree species diversity. Under-planting and/or planting canopy openings may be necessary to attain the desired stocking and mix of tree species. Select tree species which are matched to the habitat type and which improve species diversity.

Timber Sale Contract Guidelines (Current as of 1/30/2012)

As the EAB quarantine boundaries and rules have changed over time, so have our timber sale contracts. Since 2005, all State Forest timber sale contracts have contained a general EAB specification and warning (7.3.1 - Emerald Ash Borer (2/05)). Because the entire LP is under quarantine, we are taking no other action in the LP. In the UP quarantined areas, we are including a standard EAB specification, e.g. item B below, contract specification 7.3.1.1 or 7.3.1.2. If the quarantine area in the UP expands, we should also write letters to our purchasers with open contracts in these new areas, warning them about the new quarantine requirements (e.g., item C below).

- A. All contracts in the State now include the following standard General Condition specification:

7.3.1 Emerald Ash Borer. In the event that this area is quarantined for the emerald ash borer (*Agrilus planipennis* (Fairemaire)), the contract may be amended. This change may be selectively imposed on a specific portion of the sale, or it could apply to the entire sale. The DNR may either modify or cancel this contract regardless of when such facts become known. Purchaser has the duty to report a suspected discovery of emerald ash borer to the Unit Manager. Operations in the area may be suspended pending further investigation of the site.

- B. In addition, staff should add one of the following specifications to all new contracts that are in an Upper Peninsula EAB quarantined area:

- 1) When no ash or "firewood" is included in the contract, the following Standard Condition should be included in the contract:

7.3.1.1 Emerald Ash Borer, no ash or firewood on sale. There is no ash or "firewood" in this sale, but it is located within an emerald ash borer quarantined area. The Director of the Michigan Department of Agriculture (MDA) by the authority of Act No. 72 of the Public Acts of 1945, as amended, and Quarantine Regulation No. 620, has promulgated this quarantine to prevent the further spread of this pest and sets forth: definitions, regulated articles, regulated areas, conditions of movement, violations and penalties, and special exemptions. The purchaser must comply with this quarantine. Contact the MDA for further information.

- 2) When ash or other “non-coniferous firewood” is included in the contract, the following Standard Condition should be included in the contract:

7.3.1.2 Emerald Ash Borer, ash or firewood on sale. There is ash and/or “firewood” in this sale and it is located within an emerald ash borer quarantined area. The Director of the Michigan Department of Agriculture (MDA) by the authority of Act No. 72 of the Public Acts of 1945, as amended, and Quarantine Regulation No. 620, has promulgated this quarantine to prevent the further spread of this pest and sets forth: definitions, regulated articles, regulated areas, conditions of movement, violations and penalties, and special exemptions. The purchaser must comply with this quarantine. Contact the MDA for further information.

- C. For current open contracts that become part of an EAB quarantined area and that do not contain an EAB contract specification, staff should:

Write a letter to the purchaser that includes the information in specification **7.3.1.1** or **7.3.1.2**, as appropriate. Make it clear to the purchaser that MDA is responsible for the quarantine. Give them an MDA contact, if known. Direct them to the EAB website (www.michigan.gov/eab).

If MDA and the purchaser cannot work out an agreement to harvest the wood in compliance with the regulations of the quarantine, we may consider helping the purchaser by modifying the contract. This will only be done on a case-by-case basis with division approval. Remember that **General Specification 7.5 – Loss** (2/04) states that: “The State of Michigan is not responsible for loss of forest products due to insects, disease, or weather conditions.” Only in rare situations would the State take the responsibility for the loss.

APPENDIX A: The Emerald Ash Borer

The Emerald Ash Borer (EAB) (*Agrilus planipennis* Fairmaire) was discovered feeding on ash (*Fraxinus* spp.) in Southeastern Michigan in 2002. This was the first detection of this exotic beetle in North America. As of 2009, EAB has been found in 10 states and is widely dispersed in Ontario, Canada. The EAB has killed millions of ash trees of all species and varieties. This impact to date has primarily occurred in the generally infested core areas of Southern Michigan, Northern Ohio, and Northern Indiana. The initial introduction of EAB likely occurred in Southeastern Michigan in the early 1990s.

Ash trees native to North America appear to have little to no immunity to EAB. Thus, as EAB spreads throughout Michigan, it will significantly impact the vigor and survival of Michigan's 700 million white, green and black ashes.

Populations of EAB are spreading at a rate of about ½ mile per year (Conversation with Dr. McCullough, MSU). New remote EAB populations called "outliers" created mostly by the movement of infested firewood have been detected throughout Michigan. Most of these resulted from movement of firewood prior to the 2002 detection and resulting regulatory actions. Undetected EAB outliers likely exist in the unquarantined counties of Michigan's Upper Peninsula (UP). It is currently unclear how long it will take outlier populations to build and spread to all ash resources. Regulatory efforts by the Michigan Department of Agriculture (MDA) to stop movement of EAB to the UP have been effective. The MDA continues to monitor and regulate the movement of ash and hardwood firewood across the Mackinac Bridge.

We have much to learn about predicting EAB impacts. A portion of EAB populations infesting healthy, vigorous ash appear to be pushed to a two year life cycle. Thus, we may be able to slow the spread and buildup of EAB populations by both reducing ash basal area and in doing so, removing declining and poor vigor ash.

One thing is sure: the emerald ash borer is a new, serious limiting factor for all *Fraxinus* species. A limiting factor is a biotic or abiotic causal agent (e.g. an insect, disease or drought prone site) that has a negative influence on a tree's (in this case an entire genera's) ability to thrive.

Regulatory Considerations

Efforts to eradicate EAB populations are no longer feasible. All counties in the Lower Peninsula (LP) and four counties in the UP are under quarantine. The quarantine restricts the movement of regulated articles. Regulated articles include ash nursery stock and green lumber; any other ash material including logs, stumps, roots, branches, as well as composted and uncomposted wood chips. All hardwood firewood is regulated.

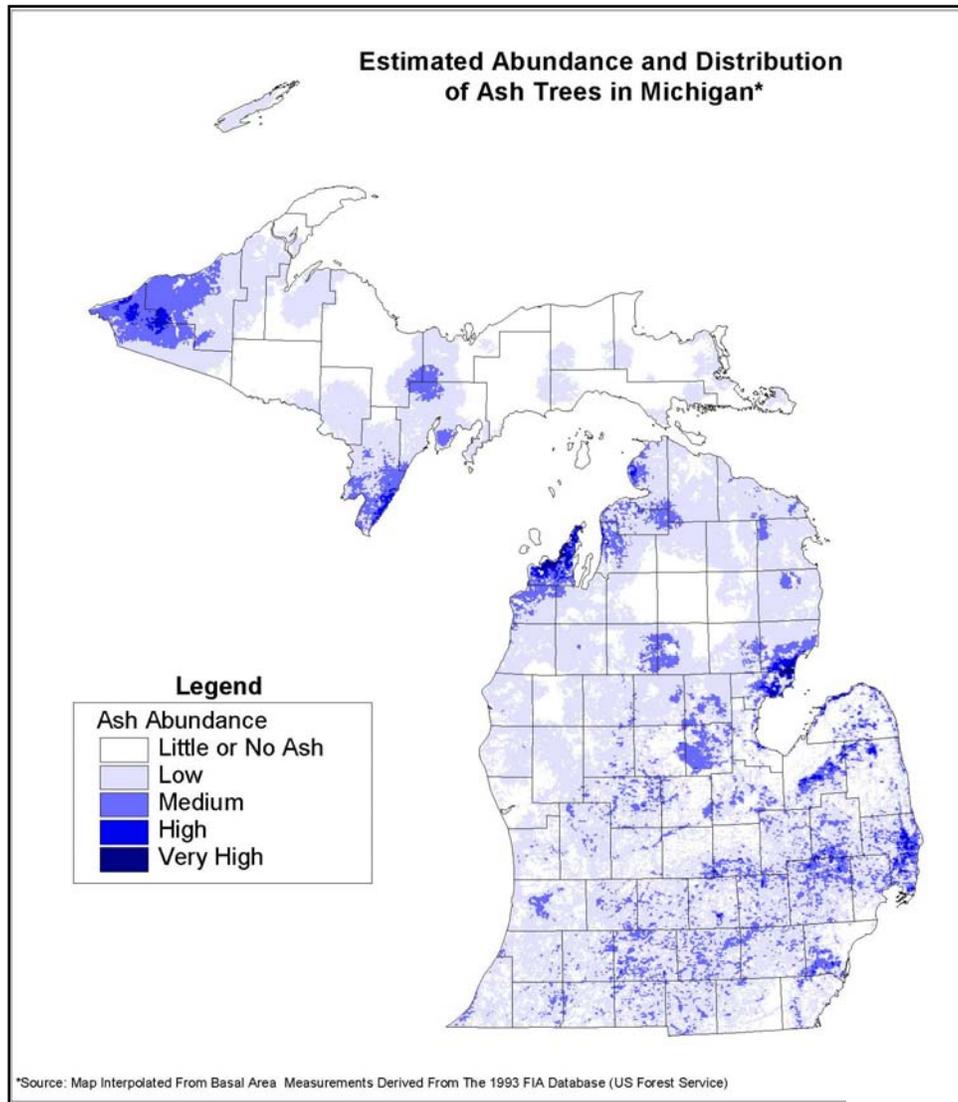
See Appendix J: Ash Containing Timber Sales and the EAB Quarantine, or visit the MDA website for specific quarantine language and updates at: <http://www.michigan.gov/mda>.

APPENDIX B: Ash Containing Timber Sales and the EAB Quarantine

Neither ash products nor hardwood firewood can be transported from an EAB quarantined area without MDA compliance agreements and permits. Visit the MDA website for up-to-date quarantine language and quarantine boundaries at: <http://www.michigan.gov/mda> .

Timber sales containing ash should have language citing necessary compliance with MDA regulations (see Appendix I). You cannot move ash products or nonconiferous firewood out of a quarantined area, or through a non-quarantined area to get to another quarantined area such as a mill site, without MDA compliance agreements and permits.

APPENDIX C: Ash Distribution Map from USDA Forest Service, Forest Inventory & Analysis Data Points (Created by Frank Krist, MDNR, FMFM in 2004)



APPENDIX D: Michigan's Ash Resource Values in Brief

White ash (*Fraxinus americana*) is the most common and useful native ash, but is never a dominant species in the forest. It is a major component in the forest cover type White Pine-Northern Red Oak-Red Maple and is a common associate in 25 other forest cover types.

Green ash (*Fraxinus pennsylvanica*) is the most widely distributed of all the American ashes. Naturally a moist bottomland or streambank tree, it is hardy to climatic extremes and has been widely planted in the Plains States and Canada.

Black ash is a major hardwood type on lowlands in the northern Great Lake States, along with American elm (*Ulmus americana*) and red maple (*Acer rubrum*). Black ash is also a common component in the beech-maple (*Fagus-Acer* spp.) climax community. It is typically a seral species with black spruce (*Picea mariana*) in bogs or where there is excess water. Black ash is a dominant species in northern Wisconsin and the Upper Peninsula of Michigan.

The USDA Forest Service Resource Bulletin NC-170 titled "Michigan Forest Statistics, 1993" presents the most current forest inventory data for all ownerships. It lists 661 million ash trees of good quality with a one inch or larger diameter at breast height (dbh). There were a reported 38 million ash with a dbh > 9 inches. Ash is reported in a combined category with elm, cottonwood and soft maple which represents 1.6 million acres or 8.6% of Michigan's forestland. The estimated combined volume of white and green ash is 2.2 billion board feet, and black ash is 475 million board feet. The volume of ash harvested annually by the Michigan DNR is estimated at 18.5 million board feet.

Wildlife Values

White ash is an important source of browse and cover for wildlife. White ash's ability to readily form trunk cavities if the top is broken and its large dbh at maturity make it highly valuable for primary cavity nesters such as red-headed, red-bellied, and pileated woodpeckers. Once the primary nest excavators have opened up the bole of the tree, it is excellent habitat for secondary nesters such as wood ducks, owls, nuthatches, and gray squirrels.

White ash provides hiding and thermal cover for a variety of mammals and birds. It provides good environmental protection during one or more seasons for white-tailed deer, small mammals, small nongame birds, upland game birds and waterfowl. The winged seeds provide food for many kinds of birds. Seeds are eaten by wood duck, bob white, purple finch, pine grosbeak, fox squirrel, mice and many other birds and small mammals. Green ash produces large seed crops which also provide food to many kinds of wildlife.

Black ash twigs and leaves provide spring and summer browse for white-tailed deer and moose. The bark of young trees is occasionally used as food by beaver, porcupine, and rabbits. The seeds are an important food for game birds, songbirds, and small mammals.

Urban Forest Values (These guidelines do not address Urban Forestry Issues.)

White ash is used in yard, street, and roadside plantings and also has been planted on strip mines with some success. The USDA Forest Service's National Urban Forests recently reported that ash species comprise between 0.5% - 2% of total leaf area (30-90 million trees) of USA urban forests, representing a value of \$20-60 billion.

Other Uses and Values

The juice from the leaves of white ash can be applied topically to mosquito bites for relief of swelling and itching. White ash has a specialized use as a prophylactic measure for snake bite. If one carries the crushed leaves in his/her pockets, the odor has been "proved" offensive to rattlesnakes...a feature of limited value in Michigan.

Green ash is often the dominant tree in city plantings, ornamentals, golf courses, etc. Green ash in riparian areas provides shade to cool water, stabilizes soil, and provides important riparian wildlife habitat.

The economic and cultural value of ash among Native Americans cannot be overlooked (See Appendix J: Ash trees, Indigenous Communities and the EAB).

Ecologically, black ash is often the only tree in swampy areas. It plays a role in soil nutrient dynamics, ground water regulation, and provides wildlife habitat.

APPENDIX E: State Forest Land Inventory with Identified Ash Components*

White Ash

Unit	Number of Stands	Stand_acres	Ash Cords	% of Stand Cords	% of Stand BA
Atlanta	112	3,879	14,159	22%	20%
Baraga	5	267	582	7%	8%
Cadillac	74	741	1,929	11%	20%
Crystal Falls	42	842	17,671	16%	15%
Escanaba	67	1,673	6,662	22%	23%
Gaylord	208	16,733	55,838	16%	16%
Gladwin	427	11,593	58,449	32%	31%
Grayling	16	315	844	14%	14%
Gwinn	33	885	3,410	20%	19%
Newberry	8	437	767	13%	16%
Pigeon River	19	786	2,252	18%	17%
Roscommon	30	1,028	4,349	55%	48%
Soo	44	1,273	3,686	24%	26%
Shingleton	12	321	1,114	18%	21%
Traverse City	54	1,960	6,604	17%	17%
	1,151	42,733	178,316	20%	21%

(*2004 Inventory Data. Hardwood stands with ash inventoried as mixed hardwoods are not included. Twenty percent of Michigan's 4 million acre forest resource has a mixed hardwood component.)

Black Ash

Unit	Number of Stands	Stand_acres	Ash Cords	% of Stand Cords	% of Stand BA
Atlanta	174	4,409	14,767	33%	34%
Baraga	19	670	1,730	14%	29%
Cadillac	186	5,513	14,262	18%	32%
Crystal Falls	201	4,657	82,743	36%	38%
Escanaba	627	10,083	51,914	43%	44%
Gaylord	168	6,570	16,261	26%	27%
Gladwin	362	9,952	48,471	41%	42%
Grayling	73	921	2,939	35%	37%
Gwinn	404	8,992	35,422	33%	34%
Newberry	22	2,077	3,117	17%	18%
Pigeon River	114	2,053	5,459	33%	36%
Roscommon	191	6,789	27,148	37%	31%
Soo	56	1,139	3,204	37%	39%
Shingleton	103	3,704	8,024	22%	24%
Traverse City	188	5,416	16,695	35%	36%
	2,888	72,945	332,156	31%	33%

All Ash

Unit	Number of Stands	Stand_acres	Ash Cords
Atlanta	286	8288	28926
Baraga	24	937	2312
Cadillac	260	6254	16191
Crystal Falls	243	5499	100414
Escanaba	694	11756	58576
Gaylord	376	23303	72099
Gladwin	789	21545	106920
Grayling	89	1236	3783
Gwinn	437	9877	38832
Newberry	30	2514	3884
Pigeon River	133	2839	7711
Roscommon	221	7817	31497
Soo	100	2412	6890
Shingleton	115	4025	9138
Traverse City	242	7376	23299
	4,039	115,678	510,472

APPENDIX F: Ash Silviculture Notes & Excerpts from Silvics of N. America: Vol. 2 Hardwoods

Summary Notes submitted by Jim Bielecki, Timber Management Specialist:

White Ash readily regenerates in our upland northern hardwood stands. Recently cut stands, one to three years after a thinning or selection cut, often contain large amounts of ash seedlings. They don't last long though, definitely less than ten years. As mentioned in the literature, ash needs a lot of light if it's to recruit to the sapling stage. Our 30' regeneration holes are designed to encourage hard maple regeneration, not white ash recruitment from seedling to sapling. I know that Mike Walters (Forest Ecologist, Michigan State University) is recommending much larger regeneration holes if you want to encourage other hardwood species to regenerate.

As for what species we can plant in the hardwood type after the ash and beech are removed, oak (acorns) and white pine come to mind. Maybe white spruce in some spots too. We could also try hemlock if the site has a north or east aspect and some shade.

I. Excerpts from Silvics of North America: Volume 2 Hardwoods

A. **Green Ash** (*Fraxinus pennsylvanica*)

- The large seed crops provide food to many kinds of wildlife.
- Natural stands of green ash are almost completely confined to bottom lands, but the species grows well when planted on moist upland soils.
- Green ash most commonly is found on alluvial soils along rivers and streams and less frequently in swamps.
- Stumps of sapling and pole-size green ash sprout readily.
- Natural stands appear to support sufficient volume to allow commercial thinnings at 25 to 30 years (6).
- To ensure reasonable volume production and reduce epicormic branching in the residual stand, basal area should not be reduced below 100 to 120 ft²/acre. This should be represented by about 100 to 120 trees/acre.
- The extensive root system of this species makes it relatively windfirm.
- Green ash seedlings, and probably older trees, have certain rooting habits or adaptations that enable them to withstand flooding.
- Green ash varies from intolerant to moderately tolerant to shade in the northern part of its range.
- It is less able to maintain its position in the crown canopy than some of its more rapidly growing associates such as red maple.
- In the southern part of its range, green ash would be considered tolerant when young and moderately tolerant as it grows older.
- Green ash wood, because of its strength, hardness, high shock resistance, and excellent bending qualities, is used in specialty items such as tool handles and baseball bats but is not as desirable as white ash.
- It is also being widely used in revegetation of spoil banks created from strip mining.
- Green ash is very popular as a shade tree in residential areas because of its good form, adaptability to a wide range of sites, and (past) relative freedom from insects and diseases.

B. **White Ash** (*Fraxinus americana*)

- White ash also called Biltmore ash or Biltmore white ash, is the most common and useful native ash but is never a dominant species in the forest.
- It grows best on rich, moist, well-drained soils to medium size.
- The winged seeds provide food for many kinds of birds.
- White ash has demanding soil fertility and soil moisture requirements.

- Soil moisture is an important factor affecting local distribution. Best growth occurs on moderately well drained soils.
- Stumps of freshly cut seedling and sapling white ash sprout readily.
- White ash is a pioneer species that establishes itself on fertile abandoned fields in several parts of the country.
- When young, white ash is a shade-tolerant tree. Seedlings can survive under a canopy with less than 3 percent of full sunlight but grow little under these conditions. Seedlings that receive sufficient sunlight grow rapidly. With increasing age, white ash becomes less tolerant of shade and is classed overall as intolerant. The decrease in shade tolerance with increasing age is reflected in the fact that young white ash is abundant in the understory of northern hardwood stands, but few grow into the overstory unless provided with light from above.
- It owes its position in the final overstory to its ability to persist for a few years in moderately dense shade and to respond quickly to openings in the canopy created by death or other causes.
- Dominant or codominant white ash responds readily to thinning and within a few years will increase its crown area to take full advantage of any reasonable release.
- Because white ash wood is tough, strong, and highly resistant to shock, it is particularly sought for handles, oars, and baseball bats.

Damaging Agents

- Ash decline (also called ash dieback) is the most serious problem affecting white ash. Especially prevalent in the northeastern part of the tree's range, this disease complex occurs from the Great Plains to the Atlantic coast between 39 and 45 degrees north latitude.
- The disease, ash yellows, caused by mycoplasma-like organisms (MLO), has been found associated with most of the dying trees where ash decline is conspicuous. However, since not all dying trees are infected with MLO, ash decline is thought to result from multiple causes.
- Drought-weakened trees may be invaded by cankercausing, branch-girdling fungi such as *Fusicoccum* spp. and *Cytophorna pruinosa*.
- Additional stresses that may be involved in the etiology of ash decline are air pollution, leaf-spotting fungi, and viruses. Control recommendations are based primarily on maintaining good tree vigor.
- Air pollution damages white ash. It is rated as sensitive to ozone and is severely injured by stack gases from soft coal consumption and from industrial processes, both of which emit sulfur dioxide.
- White ash seedlings are easily damaged or destroyed by deer and cattle browsing. Rabbits, beaver, and porcupine occasionally use the bark of young trees for food.

C. Black Ash (*Fraxinus nigra*)

- Black ash is a slow-growing tree of northern swampy woodlands.
- The seeds are an important food to game birds, songbirds, and small animals, and the twigs and leaves provide browse for deer and moose.
- Black ash typically grows in bogs, along streams, or in poorly drained areas that often are seasonally flooded.
- As would be expected of a species that grows in areas with a high water table, Black ash has a relatively slow growth rate. Site index at base age 50 years ranges from 50 to 80 in northern Wisconsin and Michigan.
- Black ash has a shallow and fibrous root system, particularly well adapted to growth under conditions of high soil moisture.
- Black ash is classed as intolerant of shade.
- A study based on an extensive survey of defects in Ontario forest trees concluded that black ash is the most defective of eight deciduous species.
- Deer browse heavily on young black ash and if poplars are scarce, beaver will cut down ash between 10 to 20 inches in stump diameter.

- There are no known races or hybrids of black ash.
- Black ash wood, easily split, has been much used for baskets.
- Many aspects of this tree are unknown because it has never been commercially important.

II. Excerpts from “The Complete Marker: A Guide to Managing Northern Hardwoods on Michigan State Forests” (edited by Jim Bielecki):

The objective of these silvicultural prescriptions is to produce high quality sawtimber and veneer logs via uneven age management that maintains stand health and provides a high quality product.

A. **Pole timber**

- Use a graded scale for pole hardwood stands. Generally, as the average residual diameter of the stand increases, increase the residual BA.

DBH	Percent Crown Cover	
	80%	90%
4"	39.0	
5"	45.7	
6"	51.4	
7"	56.8	
8"	61.1	
9"		
10"		72.8
11"		76.6
12"		79.6
13"		82.5
14"		85.6
15"		87.3
16"		89.8
17"		91.5
18"		93.3
19"		95.2
20"		97.1
21"		99.1
22"		100.0
23"		101.0
24"		102.0

- Create between 4 -10 snag and den trees/acre as per draft Down & Dead Wood Debris policy drafted by Mahalak (Retired State Silviculturalist) and Gary Bouchelle (Retired Regional Wildlife Manager) in the 1990s.

B. **Saw timber**

- Thin to 85 BA
- Residual stand structure: all size classes up to 22" DBH
- Use the “Big Tree” guideline to allow for larger DBH in selected stands.
- Create between 4 – 10 snag or den trees be left per acre.

APPENDIX G: Ash Phloem Model: Relating Tree Size to EAB Population Potential.

Michigan Technological University Ash Reduction Model
Tara L. Eberhart, Andrew J. Storer, Linda M. Nagel

Michigan Technological University created a website (<http://www.ashmodel.org/>) to aid management decisions involving ash tree removals intended to reduce potential EAB population densities. Presented is a simple model of relationship between diameter limit of harvest and percent of phloem removed for conical ash trees with no branches.

At high emerald ash borer (*Agrilus planipennis*) population densities, all green, black and white ash trees are susceptible to attack. Reduction of EAB populations in local areas is achievable by significant reductions of breeding substrate represented by phloem tissue in ash trees.

The model calls for diameter limit cutting of ash. This approach has the added advantage of retaining an ash component, thus preserving ash genetics and maintaining ash as a viable part of the forest. Depending on management goals, this model can produce both lower diameter limits to retain small trees and upper diameter limits to retain some large trees.

APPENDIX H: Education & Outreach

Education and outreach is a critical component to the overall EAB/ash management strategy. Artificial spread of EAB through the movement of ash firewood is the primary mechanism of long-range spread of the beetle. Outlier infestations were discovered in all but 6 counties of Michigan's Lower Peninsula. In most cases, these outbreaks were caused by the movement of EAB infested ash firewood into the area. It is critical that the message of not moving firewood continues to be at the heart of EAB education and outreach efforts to slow the beetle's spread.

The Michigan Department of Agriculture (MDA) created "Don't Move Firewood" billboards. These billboards can be found around the state along major highways. The USDA Animal and Plant Health Inspection Service (APHIS) developed a tri-state "Don't Move Firewood" billboard campaign. These billboards can be found along major highways along the southern border of Michigan and the northern borders of Indiana and Ohio. The USDA APHIS also created "Don't move firewood, it BUGS me!" car bumper magnets that are being distributed nationally.



Figure 1 MDA Billboard



Figure 2 APHIS Billboard (1 of 3 designs)

Education and Outreach Messages

In addition to communicating the "Don't Move Firewood" message to the general public, there are other outreach efforts that local foresters and resource professionals can provide to assist in creating sustainable, rural and urban forests, including:

- Community based technical forestry assistance.
- Educating the public about their role in reducing the impact of EAB.
- Training impacted communities, residents and resource professionals to recognize and understand:
 - EAB signs, symptoms and impacts;
 - EAB and ash management options;
 - Hazard tree management;
 - MDA's quarantine, regulatory program and restrictions (compliance agreements);
 - Wood utilization options to ensure the best use of the resource and decrease the costs associated with tree removal and disposal;
 - DNR's firewood regulations;
 - Programs that can assist landowners and communities in managing their forest resource.

Available Information

The Michigan DNR, MDA, Michigan State University, MSU Extension, USDA Forest Service and USDA APHIS have developed communication tools to assist foresters and resource professionals in communicating information about EAB and forest management. The following websites will provide access to a wealth of information to assist in education and outreach efforts.

www.emeraldashborer.info – Michigan State University (webmaster)

A clearinghouse of information for the tri-state (Michigan, Ohio and Indiana) region. The site includes EAB Powerpoint presentations, MSUE bulletins, public service announcements and the latest EAB research.

www.michigan.gov/dnr – Michigan Department of Natural Resources

Find information on DNR programs that focus on Michigan's forest resource (private, commercial, state owned and urban forests).

www.fs.fed.us – USDA Forest Service web site.

www.treesearch.fs.fed.us/ – On-line directory of USDA Forest Service publications.

www.michigan.gov/eab – Michigan Department of Agriculture.

Provides the latest information on the EAB quarantine (including maps), MDA's regulatory program, and municipal tree removal program. Also includes communication tools including public service announcements, electronic versions of EAB literature and an EAB photo gallery.

<http://www.aphis.usda.gov/ppq/ep/eab/> – USDA Animal and Plant Health Inspection Service.

Presents information on the national EAB strategy including the federal EAB quarantine. Also includes an EAB photo gallery.

<http://www.emeraldashborer.org> – Michigan Technological University.

Emerald Ash Borer Detection Project website also including the Ash Reduction Model for forest managers.

Local Michigan State University Extension offices, DNR Service Centers, MDA Regional Offices and Conservation Districts are also good sources of information.

APPENDIX I: MDA Regulatory Activity on State Lands

The following memo from Cara Boucher helps define protocols for MDA control/containment activities on state lands:

*Procedure Direction for EAB Outlier Control on State Forest Lands.
(Memo to Affected Units, Cara Boucher, 3/29/2005)*

The Michigan Department of Agriculture (MDA) is intensively surveying the Upper Peninsula for the emerald ash borer. If detected, they will evaluate the feasibility of eradicating detected populations. This depends on the extent of the infestation, marketability of the affected ash resources, and the size and accessibility of the affected ash resource. We have been cooperating and working with MDA on their efforts and continue to do so. Our responsibilities as state forest land managers include documenting, tracking and monitoring activities on state forests (Part 5, PA 451, 1994; MCL 324.504, State Land Use Rules). We use several instruments to carry out this responsibility such as leases, contracts and permits. For EAB control activities on state forest land, a Use Permit (PR 1138E) should be completed. The FMU Manager should contact and work with the local MDA site coordinator to have MDA complete the permit. Each outlier site should have a Use Permit completed for that area. Include the following on the Use Permit: In Description of State-Owned Land: 1) Township, Range, Section; 2) Forest, Compartment, Stand number (to update the OI / IFMAP database). In Authorized Land Use: Control activities for Emerald Ash Borer in accordance with MDA protocol and with DNR specifications (Note: also include specific activities, for example girdle 17 ash trees, fell girdled trees in November 2005). In the Special Conditions Section: 1) All fees, charges and performance bond requirements are waived; 2) Condition #10 Liability—waived; 3) Condition #11 Indemnification—waived. I have attached a copy of the Use Permit and State Land Use Rules for your information. If you have any questions, please contact Ron Murray (EAB), Dave Spalding (Use Permit), or me.

APPENDIX J: Ash Trees, Indigenous Communities and The Emerald Ash Borer

The indigenous peoples of the Great Lakes region (Ho-Chunk, Menominee, Odawa, Ojibwe, Oneida, Potawatomi and others) have long standing relationships with each species of ash tree (*Fraxinus sp.*) found in the regional flora. These trees have been historically and are currently relied upon for multiple uses, most notably the use of black ash (*Fraxinus nigra*) wood splints by traditional basket makers. Here I present a general summary to describe the relationships between the indigenous communities and the natural resources of the Great Lakes region. I also suggest the importance of including Tribal and First Nation communities in local and regional EAB abatement projects.

Land Tenure Traditions

Indigenous people have been ecological stewards of the land and natural resources of the Great Lakes region for thousands of years. Traditions vary, but teachings in most communities suggest that the lands and waters of our respective homelands take care of us and we must, therefore, reciprocally take care of our homelands. We are expected to take good care of our home place so that our descendants will have the opportunity to live as we live, dependant upon and connected to a diverse set of ecosystems. This land tenure responsibility has existed for thousands of years and continues to this day.

I want to clarify what I mean by dependency. When I say we are dependant upon the ecosystems in our home areas, I mean specifically that many people in Indian communities have physical, financial and spiritual relationships with land and water resources. For example, many of our families eat foods that come from our homelands including fish, deer, moose, wild rice, maple sugar, berries, etc. Many of us also pay our bills from funds that we earn selling arts and crafts, firewood, fish, land leases, and so forth. Finally, many of us rely upon medicinal plants, ceremonial sites, sacred places and teachings that are directly tied to the lands and waters of this region.

Within Indian communities, plants and animals are regarded as much more than just physical resources. They are seen as living, spiritual entities. They are members of our community and they are our relatives.

Ash Preservation in Indian Country

Within local indigenous communities, the people who carry the most knowledge about black ash are the basket makers. Basket traditions are usually maintained within certain families, and those families often rely on plant materials such as black ash splints, along with their artistic talents, to financially sustain themselves. Members of these families are very knowledgeable about black ash distribution and ecology and many are actively involved in protecting ash from EAB. If you are working on a local or regional EAB project, I suggest you connect with traditional basket makers because they hold many generations worth of traditional ecological knowledge that will likely be relevant to your project.

Although the most fervent drive to protect black ash resources might be found within basket making families, most members of Native communities in the Great Lakes recognize the critical importance of protecting all ash for future generations. These community members may currently serve or be interested in serving as volunteers in ash protection and EAB abatement projects and could help to bolster your existing core of volunteers. Additionally, many Native communities in the region have natural resource and environmental departments that are actively managing lands and engaging in forest protection. Many of these Tribal/First Nation natural resource and environmental departments

(along with cultural and historic preservation departments) are working on EAB projects and should be included in EAB management and problem solving teams. These departments are also your best pathways to the aforementioned basket makers and would-be volunteers.

Everyone who is interested in fighting EAB comes to the table with a different set of teachings and a different understanding of what it will take to protect ash into the future. It is critical that Tribes/First Nations, federal, state, nonprofit and private entities all work together to devise management strategies that will diminish this prolific forest pest.

Nick Reo (Sault Ste. Marie Chippewa)
American Indian Liaison
Michigan State University Extension
(517) 432-7605, reo@msu.edu