Mobilizing Resources to Conserve Ash Species in Response to Emerald Ash Borer

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AN INTRODUCTION TO ASH AND EMERALD ASH BORER

Ash (*Fraxinus*) consists primarily of temperate, deciduous trees and shrubs, with ±60 species native to the Northern Hemisphere. Ash diversity is highest in China (22 species) and the U.S.A. (16 species). In Eastern North America, six native ash species are under threat of functional extinction by an exotic insect pest, emerald ash borer (EAB; *Agrilus planipennis*), introduced from Asia to southeastern Michigan, probably in the 1990s. Emerald ash borer adults feed on ash leaves, females lay eggs exclusively on ash, and larvae feed on cambial tissue in ash stems and trunks. There is no documented resistance to EAB among these six ash species, and larvae commonly infest and kill healthy and stressed mature trees and juvenile saplings alike. This severely reduces opportunities for the evolution of increased tolerance to EAB and may hasten extinction.

Native species under threat include *F. americana* (white ash) and *F. pennsylvanica* (green ash), which are widely used as stress-tolerant landscape trees, and often planted as monocultures along the streets of many communities (Fig 1). These species are also commercially harvested for timber and wood products, as are two other natives, blue and pumpkin ash (*F. quadrangulata* and *F. profunda*), that also grow to substantial size (Fig 1). Ash wood is strong and flexible, making it

Figure 1. Ash species occupy a wide range of ecological niches in eastern North American forests. White ash has a broad native range from Minnesota south to Texas and east to the Atlantic Coast, most commonly in fairly well-drained, mesic forests where it is most obvious in autumn (left image). Blue ash is associated with alkaline or calcareous soils, in a more limited geographic range in the central U.S.A. with outliers in Ontario, typically in rocky, limestone woodlands (right image).

ideal for specialized uses, including tool handles, baseball bats, artistic furniture, and bowls, and black ash (*F. nigra)* has long been used by Native Americans to make utilitarian and decorative baskets. Carolina ash (*F. caroliniana*), the sixth species native to Eastern North America, is a small tree restricted to very wet areas in the Southeastern U.S.A.

Native ash trees also provide food and shelter for wildlife, supporting a suite of at least 70 native specialist arthropods, including 21 species of North American butterflies and moths. These insect species are now being negatively impacted by EAB's spread and the resulting demise of ash trees.

THE SPREAD OF EMERALD ASH BORER AND ITS POTENTIAL CONTROL

Since its North American introduction to Michigan in the 1990s, EAB has expanded rapidly via natural dispersal and human assistance, decimating native ash trees in its path. Human-mediated dispersal (including the movement of nursery stock, wood products, and firewood) is the primary means of rapid long-distance movement, and has resulted in many new infestations. Today, firewood movement is the most serious concern. The spread of EAB is diligently tracked by an extensive trapping network and regularly documented through the publication of online maps at <www.emeraldashborer.info>.

In EAB's wake, tens of millions of ash trees have been lost, with billions of dollars invested in tree removal, disposal (to prevent EAB reproduction), and replanting. For example, nearly 10 years ago the Nichols Arboretum at the University of Michigan suffered scientific, ecological, and aesthetic losses as EAB spread rapidly through Ann Arbor. An important experimental plantation of controlled crosses of native ash species developed by Dr. Sylvia Taylor for long-term genetic and taxonomic studies was destroyed by EAB, necessitating expensive removal work. [Loss of this collection was reported in the Fall 2008 *Public Garden*, Vol. 23(3).] Simultaneously, extensive native stands around Nichols Arboretum and the University's other key garden, Matthaei Botanical Gardens, were decimated. But this is only the beginning; future costs may be enormous, considering the estimated number of remaining ash trees (as high as 8 billion). Facing such huge losses, efforts to slow the spread of EAB are needed to help limit annual economic burdens while buying time to develop and deploy biological control strategies, new treatments, and potentially resistant/tolerant ash trees. Many EAB-response strategies are already being implemented, which, if successful, provide hope for a revival in planting ash as a landscape tree and re-introducing ash to native forests where it has been lost.

THE NEED FOR ASH GERMPLASM

Prior to EAB's arrival in the U.S., ash species were considered relatively common and, as a result, ex situ ash germplasm collections were poorly developed. In 2002, as EAB spread and losses mounted, there were no recognized ash collections among North American botanic gardens in the North American Plant Collections Consortium; ash provenance collections previously assembled by foresters were neglected or entirely abandoned; and the U.S. National Plant Germplasm System (NPGS) conserved only a few ash collections. In order to provide a critical safety net against extinction, as well as to aid in research to identify and develop potentially EAB-resistant ash trees, there was an urgent need to rapidly develop well-documented and genetically diverse ex situ ash collections.

After 2002 numerous agencies began working to build ex situ collections of ash. The NPGS began working with other researchers and agencies; the USDA-Natural Resources Conservation Service began mobilizing volunteers to collect ash seeds in Michigan; the U.S. Forest Service National Seed Laboratory initiated seed collections within its agency and with numerous partners; and the Canadian Forestry Service expanded efforts to collect native ash seeds for the National Tree Seed Centre. As the NPGS curator for *Fraxinus*, I began planning a series of domestic seed-collection expeditions and established contacts with the Morton Arboretum and Beijing Botanic Garden to plan Chinese collection trips to sample potentially EAB-resistant ash populations. In addition, other botanic gardens, state forestry and natural resource agencies, and Native American communities became involved. There was a clear need for these often disparate efforts to be coordinated and use limited resources as efficiently and effectively as possible to ensure development of robust ex situ ash collections. Thus, in 2009, I agreed to coordinate this interagency effort. This was a logical move for the NPGS, the lead organization within the U.S.A. for ex situ conservation of economically important plants and their relatives.

ASSEMBLING AND CONSERVING ASH GERMPLASM COLLECTIONS

Fortunately, ex situ collections of ash can be maintained long-term in seed banks and as cryogenically preserved dormant buds. Ash can also be preserved in living collections, as long as the collections are not exposed to EAB and/or if they are able to be treated systemically with proper insecticides. Because seed banking allows large amounts of genetically diverse seed to be stored long-term at relatively little cost, our primary efforts have been to assemble comprehensive ash seed collections. We focus on developing collections with proper taxonomic identity, good initial seed quality, complete passport data, and sampling strategies that maximize the capture of genetic diversity in well-established natural populations distant from large plantings of cultivated ash trees. For each native ash species, we focus on collecting and banking seed from areas being colonized by EAB, and aim to collect from populations representing the full range of habitats where the species occurs. A website describing all aspects of this conservation project, including details about the sampling strategy and current seed-collection protocols, can be found at: <www.ars.usda.gov/sp2UserFiles/Place/36251200/Ash_Project/HomePage.html>.

Since 2007, the USDA-ARS Plant Exchange Office has supported yearly ash seed-collection trips in New England, Missouri, Illinois, Wisconsin, Minnesota, Kansas, Missouri, and Arkansas. Upcoming trips are planned for Pennsylvania and New York (in collaboration with the Arnold Arboretum). Wide year-to-year fluctuation in local seed production has slowed assembly of genetically diverse collections, particularly in areas where EAB is the greatest threat. However, summer reconnaissance trips have improved our success by helping identify sites where fall seed collections can be most effectively made. These collections, and those of many collaborators, are being incorporated into the NPGS. The majority of ash collections will be maintained at the North Central Regional Plant Introduction Station in Ames, Iowa, and collections with sufficient seeds are also backed-up at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. As of 15 March 2011, our active collection included 310 accessions representing 24 taxa, with 71% of those collections from the U.S.A. and 14% from China. Currently, 116 accessions have sufficient quantities of seed or scionwood to make them available.

And consistent with NPGS policy, these collections are freely available for bona fide research and educational purposes.

HOW BOTANIC GARDENS CAN HELP AND INFORMATION ABOUT THE AUTHOR

There are many ways that botanic gardens can assist in ash conservation. Through public education, garden visitors and students can be taught about the importance of ash and its preservation, its vulnerability to EAB, and how to recognize and slow EAB's spread. Curators can identify all *Fraxinus* accessions among their holdings and develop management plans to protect key trees with systemic insecticides. Lists of unique taxa and clones as candidates for cryogenic storage can be compiled. And, for those gardens with expertise in seed collection and/or access to natural ash populations well removed from cultivated ash in the managed landscape, garden staff can directly participate in our efforts by monitoring seed production and collecting seeds.

Mark P. Widrlechner was a horticulturist within the National Plant Germplasm System (NPGS), in Ames, Iowa, where, until his retirement in September 2011, he curated collections of herbaceous and woody ornamentals and medicinal/aromatic plants and conducted research on germplasm management, plant-climate interactions, and risk-assessment for invasive species. The NPGS has extensive collections of agronomic and horticultural crops and their wild and weedy relatives, supporting considerable research on germplasm evaluation and conservation. As noted above, NPGS collections are freely available for research and educational purposes worldwide, and information about its collections is accessible online through the Germplasm Resources Information Network database at <www.ars-grin.gov/npgs>.

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ADDITIONAL READING

In addition to the websites noted in article, here are a few more on-line resources for ash, EAB, and related topics.

Lists of alternative shade trees as replacements for ash.

Canadian Food Inspection Agency. <http://www.inspection.gc.ca/english/plaveg/pestrava/agrpla/rple.shtml>.

Indiana Department of Natural Resources. <http://www.in.gov/dnr/forestry/files/Alternatives_to_Ash.pdf>.

Iowa State University. <http://www.extension.iastate.edu/pme/EAB%20other%20forms/ShadeTreeAlt07.pdf>

Michigan State University. <http://www.emeraldashborer.info/files/e2925.pdf> .

University of Wisconsin. <http://www.entomology.wisc.edu/emeraldashborer/Alternatives%20to%20Ash%20for%20Homeowners.pdf>.

Other Websites.

Continental Dialogue on Non-Native Forest Insects and Diseases. A national efforts to communicate the advantages of using local firewood. <http://www.dontmovefirewood.org>.

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Knight, K.S., R.P. Karrfalt, and **M.E. Mason.** 2009. Methods for Collecting Ash (Fraxinus spp.) Seeds. USDA Forest Service General Technical Report. NRS-55 <http://www.nsl.fs.fed.us/gtr_nrs55_AshSeedCollection.pdf>.

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U.S. Forest Service. 2010. Proceedings of symposium on ash in North America, March 9–11, 2010, West Lafayette, Indiana. <http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs-p-72.pdf>.