ECOLOGICAL IMPACTS OF EMERALD ASH BORER IN FORESTS OF SOUTHEAST MICHIGAN

Daniel A. Herms[1], Kamal J.K. Gandhi[1,2], Annemarie Smith[1,3], John Cardina[4], Kathleen S. Knight[5], Catherine P. Herms[4], Robert P. Long[5], and Deborah G. McCullough[6]

[1]The Ohio State University, Department of Entomology, Ohio Agricultural Research and Development Center, Wooster, OH 44691

[2]Current address: University of Georgia, Warnell School of Forestry and Natural Resources Athens, GA 30602

[3]Current address: Ohio Department of Natural Resources, Division of Forestry, Columbus, OH 43229

[4]The Ohio State University, Department of Horticulture and Crop Science, Ohio Agricultural Research and Development Center,Wooster, OH 44691

[5]USDA Forest Service, Northern Research Station, Delaware, OH 43015

[6]Michigan State University, Department of Entomology, East Lansing, MI 48824

ABSTRACT

Emerald ash borer (EAB), *Agrilus planipennis*, has killed millions of ash (*Fraxinus* spp.) trees since its accidental importation from Asia. Congeneric relatives endemic to North America only colonize stressed trees, apparently as does EAB in Asia. However, EAB is killing healthy trees on high quality sites in North America, creating a wood-borer outbreak of unprecedented intensity.

We have established 38 transects containing 114 plots (0.1 ha) in forests of the Huron River watershed in southeast Michigan to quantify effects of emerald ash borer on (1) patterns and rates of ash mortality in relation to community composition; (2) successional responses to gap formation including establishment and spread of invasive plants; (3) ash seed bank and seedling regeneration dynamics; (4) ground beetle (Coleoptera: Carabidae) assemblages; and (5) dynamics of coarse woody debris accumulation.

Once trees began to die in infested stands, ash mortality increased 30 percent per year and now stands at 99.2 percent when averaged across all plots, with the majority of the few surviving trees clustered in the 1-2 inch d.b.h. size class. Rate of black ash (*F. nigra*) decline and mortality was advanced about 1 year relative to that of white (*F. americana*) and green ash (*F. pennsylvanica*). There was no relationship between ash mortality and ash density, ash basal area, ash importance, total stand density, total stand basal area, or any measure of biodiversity. From 2004 to 2006, there was a highly significant negative relationship between percent ash tree mortality and distance from the putative epicenter of the infestation in Canton Township, with mortality decreasing 2 percent with each kilometer away from the epicenter. However, this relationship was not significant in 2007, as ash mortality is nearly 100 percent in all plots.

Besides ash, red maple (*Acer rubrum*) and elm (*Ulmus* spp.) are the most common species in the understory and seedling strata, and appear poised to exploit gaps created by ash mortality. Ash species are the most common species in the seedling layer, which could facilitate ash regeneration, or provide continued host material that prolongs the EAB outbreak. Four years of intensive sampling has revealed no ash seed bank. Invasive woody plant species are present in low numbers in almost all plots, and appear poised to exploit gaps formed by ash mortality.

Trap catches and species richness of ground beetles were higher in stands with small gaps. There were significant negative correlations between numbers of ground beetles captured in pit-fall traps and size of canopy gaps, as well as percent ash tree mortality. Cluster analysis revealed

that ash mortality and gap formation had larger effects on ground beetle species composition in black ash stands than in white or green ash stands.

In 2008, we assessed the effects of EAB-induced ash mortality on patterns of downed coarse woody debris (DCWD). Volume of ash DCWD averaged 96 ± 27 m^3/ha, and did not differ significantly among species averaging about or just over 30 m^3/ha for black, green, and white ash, respectively. Total biomass of ash DCWD was 1.3 ± 0.4 Mg/ha with carbon stock equal to 0.6 ± 0.2 Mg/ha. There were no differences among ash species in total biomass or carbon stock of DCWD. There was no relationship between distance from the epicenter of the infestation and volume of DCWD. Manner of tree-fall was also assessed, with a higher proportion of all three ash species snapping at the main stem than uprooting. Rapid accumulation of DCWD following ash mortality suggests that EAB may have substantial impacts on patterns of nutrient cycling.

Complete mortality of white, green, and black ash regardless of density and community composition suggests little potential for silvicultural management of EAB. Initial studies on invasive plants, native ground beetles, and course woody debris suggests widespread gap formation resulting from ash mortality will have pervasive ecological impacts. The lack of an ash seed bank coupled with mortality of ash saplings before reproductive maturity suggests that long-term perpetuation of ash is precarious. As EAB continues to spread, it clearly has the potential to decimate ash throughout North America with ecological impacts reminiscent of chestnut blight and Dutch elm disease.