QUANTIFYING CHANGE IN RIPARIAN ASH FORESTS FOLLOWING THE INTRODUCTION OF EAB IN MICHIGAN AND INDIANA

Susan J. Crocker and Dacia M. Meneguzzo

ABSTRACT

The emerald ash borer (*Agrilus planipennis* Fairmaire; Coleoptera: Buprestidae; EAB) is an introduced beetle that kills ash (*Fraxinus* spp.) trees. While most EAB-related ash mortality has been documented in urban areas, the effects of EAB in forested settings, particularly in riparian forests, are not well known. This study utilizes forest inventory data to quantify changes in the composition and structure of riparian ash forests since the introduction of EAB to Michigan and Indiana. Estimates of the abundance, number of standing dead trees, mortality and regeneration of riparian ash were compared over time. The abundance of ash growing-stock significantly decreased across the study area between 2003/2004 and 2009. Mortality of riparian ash sharply increased in 2005. The preponderance of ash mortality was limited to riparian forests in the southeastern portion of Michigan.

INTRODUCTION

In recent years, the sustainability of the Nation's ash resource has been threatened by an exotic wood-boring beetle. Native to Asia, the emerald ash borer (*Agrilus planipennis* Fairmaire; Coleoptera: Buprestidae; EAB) was first detected in North America near Detroit, Michigan, in 2002 (Haack et al. 2002). Surveys conducted in the surrounding area soon revealed dead and dying ash (*Fraxinus* spp.) trees throughout southeastern Michigan. EAB was subsequently found in Indiana in 2004. Dendrochronological reconstruction by Siegert et al. (2009) has suggested establishment of EAB and initial mortality of ash originated in the Westland-Garden City area of Michigan around 1997-1998. Since tree mortality generally occurs 3 to 4 years after infestation, it could be concluded that EAB was introduced to southeastern Michigan during the early to mid-1990s, (Siegert et al. 2009) nearly 20 years ago.

While EAB poses a risk to ash in both urban and forested ecosystems, it represents a unique threat to riparian forests. Riparian forests tend to make up a small percentage of forested land area but they often contain a large proportion of ash. Data from the Forest Inventory and Analysis (FIA) Program of the USDA Forest Service show that riparian forests comprise 4.1 million acres, or 21 percent, of Michigan timberland, yet they contain nearly half (48 percent) of all ash trees in the State. Due to the predominance of ash in these areas, the composition and structure of riparian forests could be greatly altered by the activity of EAB.

The purpose of this investigation was to quantify the effects of EAB introduction and spread on the ash resource in riparian forests. To accomplish this goal, FIA data collected between 2003 and 2009 were analyzed to compare ash abundance, distribution of standing dead trees, mortality, and regeneration over time. Results provide an indication of how EAB presence has influenced riparian forest systems as well as insight into types of changes that may occur in other regions with EAB infestations.

METHODS

Annual inventory data from FIA, collected between 2003 and 2009, were used to analyze change in riparian ash composition in Michigan and Indiana. FIA began to collect data on an annual basis in 1999; under the annual inventory system, one-fifth of all plots (or one panel) in the State is measured each year. Once all five panels have been measured, each panel of plots will be remeasured on a 5-year cycle. For example, in Michigan, field plots measured in 2000 were remeasured in 2005. Subsequently, inventories are available for each year following the completion of the first annual inventory, using a 5-year rolling average. The first annual inventory was measured between 1999-2003 in Indiana and 2000-2004 in Michigan. For the sake of brevity, inventory periods are referred to using the last year of data collection.

Under the annual FIA plot design, all trees greater than 5 inches in diameter at breast height (d.b.h) are measured on four 24-foot radius subplots and saplings (d.b.h. between 1 and 4.9 inches) are measured on four 6.8-foot radius microplots (Bechtold and Patterson 2005). Tree variables and site attributes, including species, diameter, and physiographic class, are recorded on all subplots with

Susan J. Crocker, Research Forester, U.S. Department of Agriculture, Forest Service, Northern Research Station, 1992 Folwell Ave, St. Paul, MN 55108
Dacia M. Meneguzzo, Research Forester

a forested condition (for more information, see Bechtold and Patterson 2005). The presence and species of seedlings (d.b.h. less than 1 inch) are counted on the microplot, but detailed, individual measurements are not recorded.

Riparian ash forests were defined using only plots where ash was present and the physiographic class code was one of the following: narrow flood plains/bottomlands; broad floodplains/bottomlands; other mesic; swamps/bogs; small drains; bays and wet pocosins; beaver ponds; and other hydric. Reported estimates of abundance, number of standing dead trees, and mortality were limited to comparisons of growing-stock trees (trees 5 inches d.b.h. or larger) on timberland.

RESULTS

ASH ABUNDANCE

The number of ash trees in riparian forests significantly decreased in both Indiana and Michigan over the course of the study period. Between 2003 and 2009, the abundance of riparian ash trees in Indiana decreased by more than half, from 13 million to 6 million trees. While ash numbers declined across most of Indiana, change was concentrated in the northeastern and southeastern portions of the State. Michigan saw a 14 percent reduction in ash abundance over time, falling from 474 million trees in 2004 to 406 million in 2009. The sharpest declines in ash numbers occurred in the Lower Peninsula, particularly in counties surrounding Detroit.

STANDING DEAD TREES

In 2004, an estimated 5.6 million standing dead ash trees were recorded in riparian forests throughout Michigan. The majority of standing dead ash was located in the northern Lower Peninsula. Fewer, but a proportionally similar number of standing dead ash were recorded in Indiana in 2003—an estimated 1.2 million trees. Northeastern Indiana and the Indianapolis area had the highest numbers of standing dead ash. In 2009, the estimated number of standing dead riparian ash in Michigan increased to 6.3 million trees. In contrast, Indiana saw large decreases in the total number of standing dead riparian ash throughout the State.

ASH MORTALITY

Riparian ash mortality in Michigan was an estimated 3.3 million cubic feet per year in 2004, equal to 50 percent of total ash mortality (Fig. 1). By 2005, mortality sharply increased, more than doubling to nearly 8 million cubic feet per year; mortality remained high through 2009. In 2004, ash mortality was fairly evenly distributed throughout the state. However, by 2009, the majority of riparian ash mortality (66 percent) was located in the southern Lower Peninsula, predominately in the original six-county quarantine area of the Detroit metro area (Oakland, Macomb, Washtenaw, Wayne and Monroe counties) (Haack et al. 2002).

A similar trend in riparian ash mortality was also seen in Indiana, where mortality began to increase in 2005 and had more than doubled by 2009 (Fig. 2). Increases in mortality were not evenly distributed across the State. For example, 100 percent of Indiana's riparian ash mortality in 2003 occurred in the southern half of the State; by 2009, 64 percent of riparian ash mortality was reported in the northern half of Indiana.

RIPARIAN REGENERATION

In terms of species composition, seedling regeneration in riparian forests in Michigan remained fairly similar between 2004 and 2009. In Indiana, however, changes between 2003 and 2009 included a decrease in black ash and green ash seedlings and an increase in boxelder, silver maple, sugar maple and white ash seedlings.

DISCUSSION

The orientation and nature of riparian forests makes them especially susceptible to insect invasion since they are small in area yet contain a large percentage of the ash resource (Crocker et al. 2009). Therefore, the aim of this investigation was to use FIA data to quantify the occurrence of change in riparian forests following the introduction of EAB.

Michigan, where EAB has been active the longest, showed the greatest transformation over time. The pattern of change appears to reflect the history of EAB introduction and its subsequent spread from the Detroit metropolitan area. The preponderance of standing dead ash trees in the northern half of the Lower Peninsula are indicative of later infestations of EAB and their distribution on the landscape. Detection of areas with increases in standing dead ash trees may be a mechanism for identifying future or currently undetected EAB infestations. Minimally, the location of these dead trees may highlight areas in which to allocate additional survey resources.

An increase in ash mortality in northern Indiana provides similar evidence of the pattern of spread. Trees killed around 2003 and 2004 began to be detected widely over the landscape in 2009. A continued look at riparian ash mortality over time will likely show more mortality in southern Indiana as EAB spreads further south. Seedling regeneration data from Indiana provides evidence of changes in future species composition within the State's riparian areas. Decreasing numbers of ash seedlings were accompanied by an increased number of maple seedlings.

Future work will include incorporating geospatial data to help refine estimates of riparian areas so that we can generate riparian estimates using FIA's periodic inventory, i.e., data collected prior to 1998. In doing so, we will be better able to create a picture of the riparian landscape prior to the introduction of EAB and construct a larger picture of landscape-level changes that may result from this insect.

ACKNOWLEDGMENTS

The authors thank Greg Liknes and Kathleen Knight of the Forest Service, Northern Research Station, for reviewing this manuscript.

LITERATURE CITED

Bechtold, W.A.; Patterson, P.L., eds. 2005. The enhanced Forest Inventory and Analysis Program: national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 85 p.

Crocker, S.J.; McCullough, D.G.; Siegert, N.W. 2009. Predicting the ability to produce emerald ash borer: A comparison of riparian and upland ash forests in Southern Lower Michigan. In: McRoberts, R.E.; Reams, G.A.; Van Deusen P.C.; McWilliams, W.H., eds. 2009. Proceedings of the eighth annual forest inventory and analysis symposium; 2006 October 16-19; Monterey, CA. Gen. Tech. Report WO-79. Washington, DC: U.S. Department of Agriculture, Forest Service. 408 p.

Haack, R.A.; Jendek, E.; Liu, H. [and others]. 2002. The emerald ash borer: a new exotic pest in North America. Newsletter of the Michigan Entomological Society. 47: 1-5.

Siegert, N.A.; McCullough, D.G.; Leibold, A.M.; Teleweski, F.W. 2009. Reconstruction of the establishment and spread of emerald ash borer through dendrochronological analysis. In: McManus, Katherine A.; Gottschalk, Kurt W., eds. Proceedings, 19th U.S. Department of Agriculture interagency research forum on invasive species 2008; 2008 January 8-11; Annapolis, MD. Gen. Tech. Rep. NRS-P-36. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station: 70.

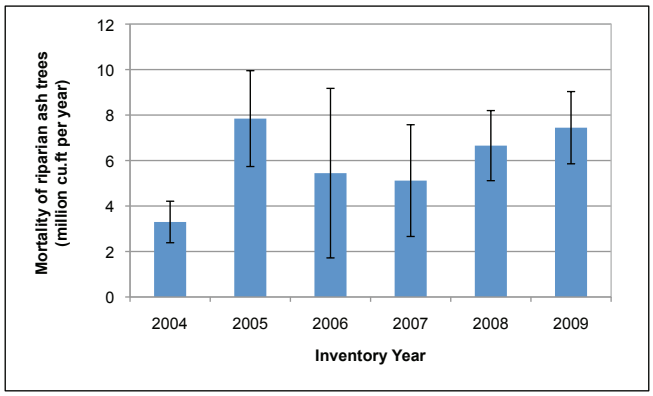

Figure 1—Mortality of growing-stock ash trees on riparian timberland, Michigan, 2004-2009.

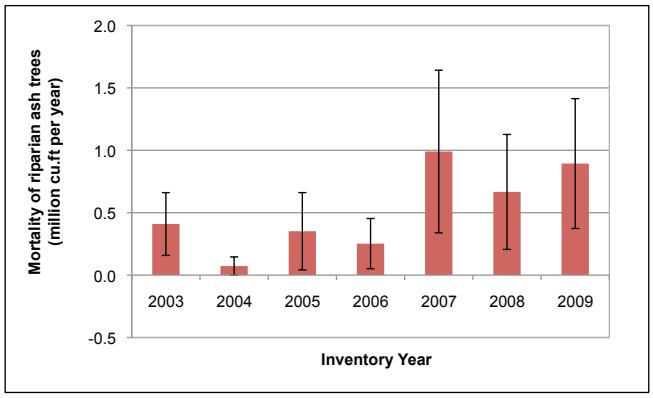

Figure 2—Mortality of growing-stock ash trees on riparian timberland, Indiana, 2003-2009.