Emerald Ash Borer Will Affect Maryland’s Eastern Shore Wetlands

Emerald ash borer (EAB) is an insect that kills all species of ash trees. EAB originated in China and was found in Michigan in 2002. It was found in 2003 in nursery stock in Charles County, Maryland. By 2017, EAB killed, or will kill in the next few years, most of the ash trees in western Maryland and west of the Bay.

EAB was found in pheromone traps on the Eastern Shore of Maryland in 2015, and in northern Delaware in 2016, adding these two areas to the other 28 states in the EAB quarantine. In 2016, dead ash trees were found in Easton, Maryland on the Eastern Shore.

The mortality of ash species in sensitive riparian and tidal areas of Maryland will cause significant ecological changes. It is unclear if ash mortality will adversely impact water quality since other species will quickly colonize the land after ash trees. However, storm surge protection may be compromised. Wildlife habitat will change and some species will benefit, while others will not. It may be necessary to control invasive species or take other actions depending on the individual circumstances.

One question for scientific researchers is how long will it take EAB to spread to the relatively inaccessible swamp areas? EAB has spread rapidly across the state and caused widespread mortality. However, it took 13 years for EAB to cause mortality in a tidal swamp at Patuxent Wetland Park in Anne Arundel County that is only 10 miles from where EAB was first found in Maryland in 2003 - movement of about 0.8 miles per year. Research studies in Maryland found the leading edge of EAB beetles moved about 0.6-0.8 miles per year in a quarantine area through natural dispersion (Sargent, Raupp, Bean & Sawyer 2010). This rate of travel is consistent with has been documented with the Patuxent site. Rapid dispersion across the state is probably due to the transport of firewood and vehicles along extensive road networks. It may be that the inaccessible nature of swamp areas by roads and human activities will delay the spread for years. Hopefully, this will allow time for the development of more effective biological controls.
Careful Observation of Ash Trees in Woodland Indicates if EABs are Active

The EAB lifecycle starts with the overwintering of the larvae under the bark (Figure 1). The adults emerge in mid-to-late May or early June, when the black locust trees usually bloom (Figure 2). They feed, mate, fly, and lay eggs. The eggs hatch and the larvae enter the trees and feed over the winter on the cambium, phloem, and sapwood when temperatures are above 50 degrees F. The larval feeding girdles the tree so water and nutrients can no longer move up and down, leading to the rapid death of the tree.

The most obvious sign of EAB damage is crown dieback and canopy thinning followed by death of the trees. Increased woodpecker activity may be an early warning sign that EAB larvae are in the trees and mortality has occurred or will soon follow.

One of the most obvious signs of EAB activity is a D-shaped borer hole in the bark (Figure 3a). As activity increases and the tree dies, the bark may show signs of splitting and falling off, exposing the larva galleries that girdle the tree (Figure 3b).

Figure 1 - EAB larvae. Photograph by Smith, K. and R. Heilgman, Ohio State.

Figure 2 - EAB beetle. Photograph by Smith, K. and R. Heilgman, Ohio State.

Figure 3. a) One definitive sign of EAB is the D-shaped larval hole; b) larval galleries and failing bark; and c) ash tree snap. Photographs.
What Happens When Ash Trees Die?

Ash trees killed by EAB decompose very quickly and become real hazards. The dead trees are not salvageable for forest products unless harvested quickly. The wood turns spongy and within a few months, large branches fall and can become hazardous to tree service workers, residents, and structures. Within a year of tree death, “ash snap” may occur, when wind or weather cause the tree to snap off above the ground (Figure 3c).

In contrast, oak trees killed by gypsy moths can be harvested for timber or firewood for at least a few years after infestation. If you have ash trees that are highly valued for forest products, you should harvest the wood before the trees die to maximize the value. If you allow them to die in the woods, be aware of the possible hazards.

Treating Ash Trees with Pesticides is Effective if Done Early on Healthy Trees

Pesticides will protect selected municipal and urban trees, and those on private properties, usually resulting in their survival. The chemical treatments can be injected or soil applied when the tree is still healthy (with about 60% of the crown intact), effectively protecting the tree from EAB damage for a one to three years. The reference, *Insecticide Options for Protecting Ash Trees from Emerald Ash Borer*, is recommended and can be found in the resources section of this report under Herms et al., 2014.

Contact a certified arborist to get an assessment of your ash trees. Injection is a costly and long-term commitment that requires reapplication. With a cost of $8-10 for each inch of diameter, it is a significant financial commitment into the foreseeable future. For homeowners who do not want to protect healthy ash trees with injections, it is much cheaper to remove the trees before or shortly after they die. Tree care industry workers have been seriously injured when branches failed as they were climbing trees with ropes while removing ash trees that recently died. Arborists now use bucket trucks and cranes to remove dead ash trees, which is safer than climbing, but means higher removal costs for homeowners.

Maryland is Developing Biocontrol Population to Develop Long-term control Across Landscape

Chemical treatment of the many ash trees in rural woodlands or tidal swamps is not practical. Maryland’s biological control of EAB involves using natural parasitoid predator wasps that inject their eggs into EAB larvae or eggs that lie under the bark. Biological control is being intensely studied in the hope that once large-scale mortality of ash trees subsides, parasitoids released into the woods will become well-established and keep EAB populations in check, allowing future ash trees to grow and survive.

A number of promising parasitoids have been released around the state at specific sites (Figure 4). The sites are revisited later to recapture the parasitoids. If they are captured in larger numbers and in locations outside the release site, they have become established and are reproducing, a positive sign that parasitoids may be able to control EAB in the future. In contrast, if the parasitoids are not recaptured in higher numbers, or do not demonstrate an expanding population, their ability to control EAB may be limited.
Tetrastichus planipennisi (known at Tet’s) have been the most promising parasitoid (Figure 5). Studies in Michigan have found that Tet populations are increasing and providing some control (Duan 2013). However, a major shortcoming is that the ovipositor that penetrates the bark to lay eggs in the EAB larvae will only be effective on trees less than four inches in diameter. A parasitoid release of a new species native to Russia, Spathius galinae, will hopefully do better in Maryland’s colder climates. Furthermore, the species has the capability to control EAB on larger diameter trees. Parasitoid research is a continuing area of applied research. Ohio and Michigan are many years ahead regarding EAB mortality and parasitoid research, so hopefully we can learn from their experience.

Figure 5 - Life cycle of Tetrastichus planipennis (Tet’s). Lays eggs in EAB larvae under the bark and young wasp’s use nutrients from larvae to develop and hatch. Other wasp’s lay eggs in the EAB egg laid by the adult.

Ash Species around the Chesapeake Bay, and Especially in Tidal Wetland Areas, are Different from those in Upland Areas

The most common ash species in Maryland are: white ash (Fraxinus americana); green ash (Fraxinus pennsylvanica); and pumpkin ash (Fraxinus profunda). Black ash (Fraxinus nigra) is localized and patchy and generally associated with swampy areas with nutrient-rich soils high in calcium. Carolina ash (Fraxinus caroliniana) is rare and restricted to a few areas along the Pocomoke River on Maryland’s Eastern Shore. The density of ash trees in Maryland woodlands is, on average, lower than in other states. However, depending on the location, ash trees may be a major component of a particular woodland area.

The distribution of ash species and the ecological niche they fill changes going from the uplands of western Maryland to the tidal and non-tidal swamps and surrounding upland areas that characterize the Eastern Shore. West of the Chesapeake Bay, white ash is a dominant species in upland areas with green ash more prominent in wetter areas. These trees reach commercial size for timber (greater than 16 inches at diameter breast height) and can be managed to provide income for landowners. The onslaught of EAB has resulted in many landowners carrying out salvage harvests before the trees die, or allowing the trees to die, decay and fall to the ground.

In general, ash trees do not reach commercial size for forest products on the Eastern Shore and are typically found in or adjacent to tidal and non-tidal hardwood swamps. These areas are very inaccessible and many landowners may not even be aware when trees die. The dominant species are pumpkin ash and green ash. Pumpkin ash is found almost exclusively in tidal wetlands of the lower Eastern Shore associated with the Pocomoke, Nanticoke, and Choptank Rivers systems. Green ash is the dominant ash species in wetlands from the Choptank River north along the northern and western sections of the Chesapeake Bay.

For more information on this and other topics visit the University of Maryland Extension website at www.extension.umd.edu
The tidally-flooded woodlands habitat borders the upper reaches of Maryland’s Coastal Plain rivers and tributaries. These habitats are species-rich and structurally complex with open canopies and diverse lower strata (layered ground vegetation). In much of our region, these freshwater habitats are dominated by mixtures of hardwoods such as ash, gum, and maple.

The Pocomoke River watershed is especially unique because bald cypress are co-dominant with ash, gum, and maple. Atlantic white cedar is also present in the Nanticoke and Pocomoke River watersheds as small stands or scattered individuals. These communities often develop in narrow areas between regularly tidally flooded areas and the upland habitats.

The shrub layer in freshwater tidal woodland is usually dense and diverse in species due to frequent flooding and hummock and hollow topography which is characteristic of tidal forests (Figure 6). Hollows are regularly inundated by tidal water. Hummocks are less frequently flooded and so support the establishment of trees and numerous herbs.

Green and pumpkin ash are associated with tidal woodlands and the trees, along with associated species, have high conservation values for protecting water quality, controlling erosion, providing diverse and sensitive wildlife habitat, stormwater surge protection and other values (Figure 7 & 8). Ash mortality affects these values and the potential establishment of invasive species is not well understood. The mortality of the tidal swamp at Patuxent Wetland Park provided an opportunity to study the impacts of a significant loss of ash trees in an area. The wetland was dominated by a green ash forest canopy but the ash trees never leafed out in 2016 after they were killed by EAB. At the end of the growing season, the impact was significant (Figure 9). The understory grew profusely under full-light conditions and the ecology of the site changed dramatically.
Figure 8 - Forests of bald cypress and blackgum with varying amounts of pumpkin ash and red maple found in tidal forests that border the mid to upper portions of the Pocomoke River and associated tributaries. Features include hummocks and hollows with numerous protruding cypress knees. Photograph by Peter Stango III.

Figure 9 - Mortality of the ash overstory (left) stimulated massive understory growth (above). Traditional hummock and hollow vegetation is being altered by the profuse vegetation growth. Left photograph by Andy Baldwin.
Green and Pumpkin Ash Mortality Affect Forest Structure and Diversity

Forest Structure and Diversity: Pumpkin and green ash make up a significant part of many tidal swamps and rapid mortality by EAB creates large openings in the tree canopy. Mortality in green ash swamps on the western shore of the Bay demonstrate a rapid change in vegetation and ecological function and structure. Before EAB, the majority of the biomass was in the tree canopy. Since the trees died, profuse understory vegetation makes up most of the biomass on the site. This creates the opportunity for invasive species to establish and displace native species.

If ash species are a minor component of the forest stand, small canopy openings may be filled over the following year(s) by such species as red maple and swamp blackgum. Red maple is a faster-growing species than swamp blackgum and it would be more likely to capitalize on the available canopy space. It is possible red maple will become a more dominant species after ash mortality and in later stand development. However, there is not sufficient research to determine how long it takes to replace a mature overstory and for other long-term changes to forest structure, diversity, and function.

Dead ash trees fall and cause potential damming of wetland channels and affect predator/prey diversity and abundance. Researchers have documented sprouting from the base of ash trees killed above the ground at the Patuxent Wetland Park site, so it is possible that the root systems may continue to resprout. If not, the hummocks stabilized by tree root systems may erode, and the swamp may become a low-lying marsh. These changes would have serious ecological implications.

Tidal Hardwood forests Provide Important Ecological Functions for Water Quality, Storm Erosion and Wildlife

Water Quality: Riparian forests are important to water quality because they catch sediment that comes from upstream freshwater runoff. Forests also minimize erosion when the land is inundated by high-water events. Riparian and especially tidal forests, are diverse and the mortality of large riparian ash areas will deposit large amounts of decaying woody debris in riparian areas and possibly increase shoreline erosion. The result is greater flow of suspended solids that contain many nutrients. Until these ecological systems stabilize, nutrient flow into the Chesapeake Bay and its' tributaries could increase. This situation should be monitored to assess short- and long-term changes.

Storm Erosion Protection: Tidal swamps with tree overstory provide a buffer during storm events. Loss of a largely ash overstory may result in more stormwater intrusion, which can cause increased damage to the stability of the wetland ecosystem or to the structure of natural upland habitats that are behind the swamps. The existing hummock and hollow topography may be compromised by profuse ground vegetation growth, lack of tree root systems that are sites for hummock formation and stability, and intrusion from nearby water bodies.

Wildlife: The mortality of ash trees will provide more habitat initially for woodpeckers and other trunk-nesting birds and wildlife. As the stand composition changes after ash mortality, there may be some impact on songbird species that rely on the habitat. The availability of mating and nesting sites may change, along with prey/predator diversity and the abundance for many wildlife species. Dead ash trees falling in the wetland channels and streams may alter some spawning and migration patterns and stream habitat diversity (Figure 10).
The loss of ash trees may not adversely affect waterfowl because nesting areas will still be available, although the species mix may change. The majority of waterfowl on the Eastern Shore are migratory and native nesters should not have a problem. However, ash tree species produce significant amounts of winged seeds known as “samaras.” These winged seeds are eaten by turkeys and other wildlife that are food sources for some wildlife species. If the seeds are not available, turkeys for example, may move to new areas during the hunting seasons. However, the impacts are hard to assess at this point in time.

**Potential Woodland Areas Impacted by Emerald Ash Borer**

Using current GIS technology and available data, the Department of Natural Resources partnered with other professionals to attempt to identify the tidal and non-tidal wetlands in the major rivers and their tributaries around the Chesapeake Bay (Figure 11) that contain ash species. These areas will be affected by ash mortality (denoted in red in Figure 11), when it occurs. The tidal and non-tidal areas that will be affected have conservation value for water quality and biodiversity, but the potential impacts are not well-understood.

![Figure 10 – Impacts to wildlife include: altered spawning migration patterns, altered stream habitat diversity, mating & nesting site availability, & altered prey diversity and abundance.](image)

![Figure 11- Tidal and nontidal forested wetlands of Maryland. Areas in red will be affected by ash mortality when it occurs.](image)
In Figure 11, the dominant watersheds around the Chesapeake Bay are denoted to provide reference points. The Pocomoke (P) and Nanticoke (N) River watersheds are located on the lower Eastern Shore and contain large stands of pumpkin ash in tidal wetlands. The Choptank (C) River watershed lies near Cambridge and also has significant amounts of pumpkin ash but green ash starts to become more dominant in the watersheds north of the Choptank River, including the Chester River (CH). The dominant ash species in watersheds on the west side of the Chesapeake Bay, such as the Patuxent River (PA), Wicomico River (W), and Mattawoman River (M), is green ash, with limited amounts of pumpkin ash.

Figure 12 provides an enlargement of the Nanticoke River on the Eastern Shore and the Patuxent River on the western shore of the Bay. The location of the wetland mortality at Patuxent Wetland Park is marked with a star.

Figure 14 shows the tidal and nontidal forested wetland areas for the Nanticoke River (N) and Pocomoke River (P). Primarily pumpkin ash is found in lower shore wetland areas. Figures 15 provides a closeup along one section of the Nanticoke River to demonstrate how important ash-dominated wetland areas are to the protection of water quality and habitat protection in general. Figure 16 highlights wetland areas in Idylwild Natural Area, and protected area valued for its biodiversity. It is easy to see that significant mortality in these areas will directly affect their conservation values.
Figure 13 - Blowup of junction of Chapel Creek and the Choptank River adjacent to North Caroline High School. Tidal wetland areas outlined in red have significant stocking of pumpkin and/or green ash and will be heavily impacted when EAB mortality occurs. Map provided by Peter Stango III, MD DNR.

Figure 14 - Tidal and nontidal forested wetlands of lower eastern shore. Map provided by Peter Stango III, MD DNR.
Pumpkin ash covers much larger swamp areas in Virginia, North Carolina, and South Carolina (Figure 17), so the impact of EAB mortality may be more severe in those states. Carolina ash (*Fraxinus caroliniana*), a small tree found in swamps throughout the southeast is another species threatened by EAB.

**Potential Impact of EAB on Hardwood Swamps of the Chesapeake Bay is not Well Understood**

The mortality of the green ash swamp at Patuxent Wetland Park on the Western Shore of the Bay provides an opportunity to study the impact of EAB. Monitoring of the Patuxent site and other swamp areas on the Eastern Shore needs to be implemented. Long-term impacts of tree deadfalls in tidal swamps and riparian areas should be monitored as well.

The following actions seem prudent given the EAB situation in Maryland:

- Establish EAB research plots in swamp ecosystems on the Eastern Shore to monitor the impact of EAB mortality as it occurs. The research plots could also try some active treatments using biological control and pesticides.
- If and when mortality occurs, plant trees of other species where trees or woody vegetation fail to colonize or regenerate the site. This may help to maintain the value of a forested wetland. The inaccessibility of the sites would make this difficult and the techniques for successful planting of acceptable species would require more research and operation trails.
Where To Go From Here – Get a Forest Stewardship Plan!

It is important for forest landowners to be aware of how EAB may impact their woodlands, but that requires knowing what you have. Landowners should get a forest stewardship plan developed by a Maryland professional forester (see Kays & Tjaden 2000). The plan itself will involve a map, and an inventory of the property divided into similar areas of vegetation known as “forest stands.” A description is developed for each stand and management recommendations and a timeline provided based on your overall objectives for the property.

In Maryland, service foresters employed by the Maryland DNR Forest Service are found in each county and they can develop a plan for a nominal fee. Private consulting foresters will also develop a plan and cost will depend on the specific property. For more information on forest stewardship planning and finding a forester go to: www.extension.umd.edu/woodland/your-woodland/find-forester.

Helpful Resources


- Maryland Department of Natural Resources. 2014. *State Wildlife Action Plan*. Maryland Department of Natural Resources, Annapolis, Maryland.

Natural Heritage Program, Annapolis, Maryland. Unpublished report submitted to the Environmental Protection Agency. 96 pp. Available at: 