Does emerald ash borer disproportionately favor stands of pumpkin ash with larger diameters?

Contributing Authors: Brady Kalchthaler*, Christopher Dolanc Ph.D

Abstract:

The emerald ash borer (EAB), *Agrilus planipennis*, is an invasive wood-boring beetle native to eastern and southeastern Asia. Mature EABs feed on the foliage of ash trees *(spp. Fraxinus*) causing little damage, while larvae feed on the phloem. Because adult beetles move around, flying from treetop to treetop, tree size would seem to impact the spread. Additionally, evidence suggests that females are limited to laying eggs on trees with prominent bark, or larger, more mature individuals. In this paper, we aim to distinguish which size classes of ash are most susceptible to an EAB infestation. We hypothesize that ash health decline and ash mortality rates will be lower among smaller ash trees. As part of an ongoing census starting in 2016, two forested plots were sampled in Asbury Woods near Erie, PA dominated mostly by pumpkin ash (*Fraxinus profunda*). Trees in both plots were identified, given an ash-rating on a scale of 1-5 (5 being the worst), and an ash break-up rating (1-5). Ashes were subdivided into three categories (<10 dbh, 10-19.9 dbh, and >19 dbh) for analysis. Results indicated the EAB prefers the size classes of 10-19.9 dbh, and >19.9 dbh. The 10-19.9 dbh category exhibited an average ash-rating of 4.21 in the year 2020, and the >19.9 dbh category exhibited an average ash-rating of 4.66. The average ash-rating in the <10 category for the year 2020, was 3.43. Lower average ash-rating correlates to healthier trees, suggesting that trees >10 dbh have a higher mortality rate due to their greater decline in health from years 2016-2020. Results do support our hypothesis, however the average ash-rating for trees in the <10 category are still declining in health, suggesting that ashes in each category are susceptible to infestations and the future of the species remains in question.

Figure 1. Emerald ash borer larvae (Top Left), mature emerald ash borer (Bottom Left), galleries formed by emerald ash borer larvae and size comparison of mature emerald ash borer (Right). (Photo credit: newhopemn.gov)

Introduction:

Agrilus planipennis, better known as the "Emerald Ash Borer (EAB)" is a buprestid beetle native to northeastern China, Japan, Korea, Taiwan, and Mongolia. The beetle was first identified in the United States in 2002, near Detroit, Michigan. Since its discovery, the invasive pest now spans across most of the eastern US and lower provinces of Canada, threating the lives of nearly 1 billion native ash trees (*Spp. Fraxinus).* The mature EAB, are slender and elongate with a metallic copper-green color, about 7.5-15 mm long (Figure 1, bottom left). They feed on the foliage, but only around the perimeter of the leaf, causing minimal damage to the tree's health. Mature EAB larvae are white, flat, slender and have a pair of brown pincer-like appendages on their last abdominal section and can reach lengths of 26-32 mm (Figure 1, right). Mature EAB females lay their eggs in well-hidden crevices found on the outer bark, and once the larvae hatch, they bore into the cambium and feast of the phloem restricting nutrient and water flow through the stem, essentially girdling the tree. The larvae's feeding habits produce "S" shaped (serpentine) colonies, filled with frass, that can be observed when the bark is removed after an infestation of EAB (Figure 1, Right).

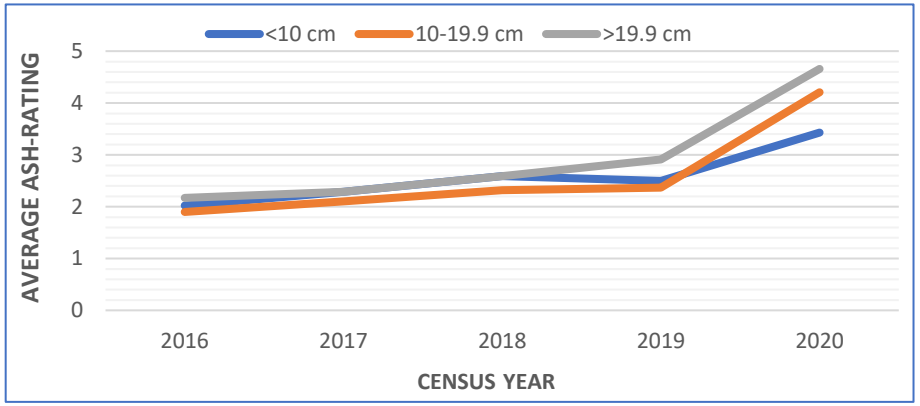

Figure 2. Average ash-ratings of each size class for each censused year. Size class 1 (Blue), size class 2 (Orange), size class 3 (Grey).

Methods:

Research on the EAB was conducted in Asbury Woods, located near Erie, PA. At this site two 20 x 20 m^2 forested plots were censused beginning in the year 2016 until 2020. Both plots were first divided into sixteen 5 x 5 m^2 squares, constructed by outlining the perimeter with metal stakes, 5m apart, then using rope to section off the individual squares. Working from section to section, all trees were first identified and assigned a tag with an identification number. Once identified, the ash trees were assessed on their individual health and assigned an "ash-rating" and "ash-breakup-rating" on a scale of 1-5. (1) symbolizing a healthy/productive individual free of an EAB infestation, and (5) symbolizing an individual that is lifeless/unproductive. All values between 1-5 symbolize varying degrees of declines in the individual's health. When assigning an "ash-rating", important factors looked for included bark health, presence of EAB exit holes, branch dieback, and epicormic sprouting. When assigning an "ash-breakup-rating", one looked for disturbances in the canopy and overall decline in health of the foliage. A diameter at breast height (dbh) in centimeters was also measured for each tree using a leather measuring tape. The measured dbh's of all trees were then separated into three size classes: size class 1 (<10 cm), size class 2 (10-19.9 cm), and size class 3 (>19.9 cm). The dbh, ash-rating, and ash-breakup-rating then be used to analyze trends in ash health decline for each of the three dbh size classes.

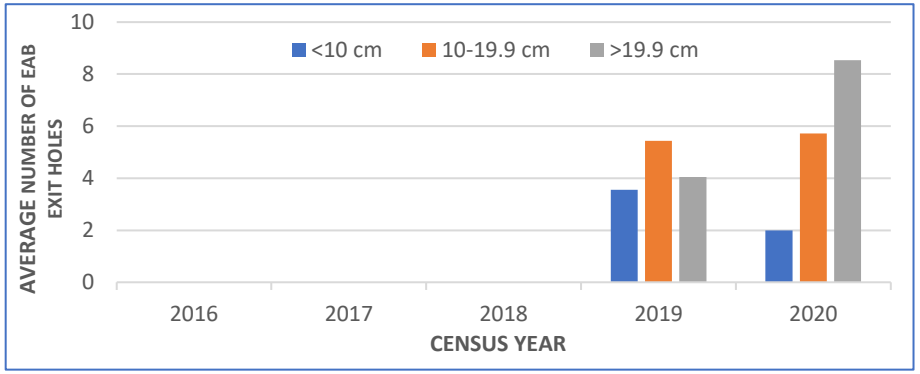

Figure 3. The average number of observed emerald ash borer exit holes discovered during each census year. Size class 1 (Blue) , size class 2 (Orange), size class 3/ (Grey).

Figure 4. Sampled plots in James Preserve, Asbury Woods, Erie, PA. Photo is from 2018 census

Discussion/Results:

Results indicate that the EAB prefer more mature, larger diameter pumpkin ash apposed to the younger, smaller diameter individuals. The average ash-ratings for all three size classes are similar until about 2018-2019 (~ 2.5), but at this point we can see that the average ash-ratings for size classes 2 & 3 are increasing at a faster rate than size class 1 ("Figure 1"). In the final census year, 2020, we find that average ash-ratings for size class 2 (4.21) and size class 3 (4.66) are steadily approaching an ash-rating value of 5, suggesting that tree death is imminent even if a biological control is implemented. On the other hand, we find that size class 1 (3.43) has a lower average ash-rating than size classes 2 & 3, but not significantly as to suggest that individuals in this size class are safe from an EAB invasion. The average ash-rating for size class 1 is steadily approaching a value of 5, just at a slightly slower pace than classes 2 & 3. In addition, the average ash-rating for all three size classes ("Figure 1") can be correlated with the number of observed EAB exit holes ("Figure 2"). EAB exit holes are found in all three size classes, but classes 2 & 3 are favored over size class 1. In 2020, size class 2 averaged three times more EAB exit holes than size class 1 and Size class 3 averaged four times more EAB exit holes then size class 1 ("Figure 2").

Conclusion:

Pumpkin ash will experience higher rates of EAB infestation and thus a higher percentage of health decline for individuals that are larger and more mature. However, this does not eliminate younger, smaller individuals from an infestation as their average ash-rating increased throughout the censused years. This ultimately indicates that even smaller pumpkin ash should not be expected to survive an EAB invasion, even though they may survive longer. All three size classes are susceptible to an EAB infestation with varying rates of health decline, and the future of the ash species remains in question until an affordable, practical control can be implanted on a mass scale.

References:

Haack, R. A. ., Jendek, E., Liu, H., Marchant, K. R., Petrice, T. R., Poland, T. M., & Ye, H. (2002, September). The Emerald Ash Borer: A New Exotic Pest in North America. *Newsletter of the Michigan Entomological Society*. https://www.nrs.fs.fed.us/pubs/jrnl/2002/nc_2002_Haack_001.pdf