Monitoring Ash Trees Tolerant to Long-Term Exposure to Emerald Ash Borer

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Introduction

Attacking all North American ash species (*Fraxinus* spp.), emerald ash borer (*Agrilus planipennis* Fairmaire [EAB]) has caused significant mortality within its introduced range. Mortality of ash trees occurs as a result of EAB larvae feeding on phloem within the trees during development following oviposition in bark crevices. The timeline for death ranges from a single year in smaller trees to 3-4 years in large trees. However, trees have been identified in southeastern Michigan, near the *de facto* epicenter of EAB introduction, that have exhibited survival even with long-term exposure to attack. The objectives of this study were to 1) continue monitoring these surviving ash trees, 2) identify mortality and survival rates, and 3) identify distinctions between resistant, resilient, and susceptible ash trees.

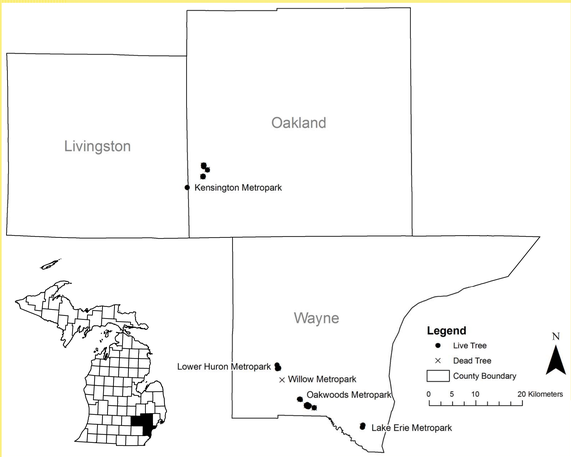

Figure 1. Tree and metropark locations in Livingston, Oakland, and Wayne Counties, Michigan.

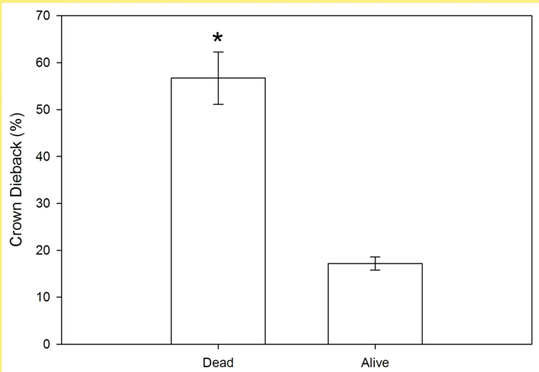

Figure 2. Mean percent crown dieback (±SE) in 2010 for trees that were dead and alive in 2011. Asterisk (*) indicates significant difference with 1-tailed t-test.

$t_{(1),191} = -9.26$
$P < 0.001$

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Methods

We visited 243 ash trees in Kensington, Lake Erie, Lower Huron, Oakwoods, and Willow Metroparks in southeastern Michigan (Figure 1). For each tree, crown vigor and dieback were assessed using methods described by USDA (2005) and Millers et al. (1991). EAB signs and symptoms were also assessed (bark splits, exit holes, wood pecks, sprouting) above and below 6 m. Two-hundred and nineteen trees were wrapped with a Tanglefoot coated plastic stem trap, 0.5 m wide, and centered at breast height. Traps were checked monthly and all captured EAB adults were removed and sexed. T-tests were used to compare crown dieback between trees alive and dead, as well as those with EAB captures and those without. Mood's median test was used to compare independence of tree mortality and vigor. Pearson's correlation was used to test the relationship between percent dieback and EAB captures.

Table 1. Percent of trees with signs and symptoms of EAB infestations in 2010 that were dead and alive in 2011.

	Above 6 m			Below 6 m			
Status	Bark Splits	Exit Holes	Wood Pecks	Bark Splits	Exit Holes	Wood Pecks	Sprouting
Dead	70.8	37.5	75.0	87.5	50.0	83.3	66.7
Alive	29.0	5.9	26.6	38.5	17.8	27.2	23.1

Note: Percent values do not sum to 100% because many trees, both alive and dead, had multiple signs and symptoms.

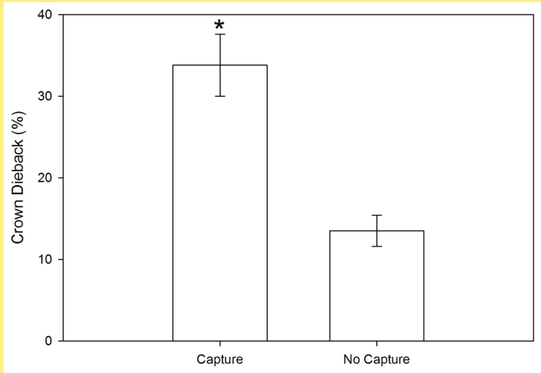

Figure 3. Mean percent crown dieback (±SE) in 2011 for trees that did and did not capture emerald ash borer adults on stem traps. Asterisk (*) indicates significant difference with 1-tailed t-test.

$t_{(1),217} = -5.30$
$P < 0.001$

Table 2. Percent of trees with signs and symptoms of emerald ash borer infestations in 2011 that did and did not capture EAB adults.

	Above 6 m			Below 6 m			
Adult Capture	Bark Splits	Exit Holes	Wood Pecks	Bark Splits	Exit Holes	Wood Pecks	Sprouting
Yes	86.1	29.1	67.1	69.6	43.0	58.2	62.0
No	55.3	9.9	29.1	34.0	9.9	18.4	22.7

Note: Percent values do not sum to 100% because many trees, both with and without captures, had multiple signs and symptoms.

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Results

Of those trees visited, 24 that were assessed in 2010 were dead in 2011 (12.4%), but 50 new trees were located and added to the study. Trees dead in 2011 had significantly greater percent dieback in 2010 than those trees that survived (Figure 2).

Trees dead in 2011 were 3.6 times more likely to have a vigor rating >2 in 2010 (83.3%) than compared to surviving trees (23.1%). As such, the frequency of trees dead in 2011 was not independent of the vigor rating >2 ($X^2_1 = 36.0$, $P > 0.001$). For all the assessments of signs and symptoms of EAB infestation (bark splits, exit holes, wood pecker activity, and sprouting), trees that were dead in 2011 had greater percent occurrences of these signs and symptoms in 2010 than those that survived into 2011 (Table 1).

All trees assessed as alive in 2011 were wrapped with the plastic sticky trap. Those trees with EAB adult captures had significantly greater percent crown dieback compared to those without captures (Figure 3). Also, EAB adult capture was not independent of vigor rating >1 ($X^2_1 = 24.7$, $P < 0.001$) with 51% of trees with EAB captures had a vigor >1, while only 19% of those without capture had a vigor >1. Trees with EAB captures had greater percent occurrence of all signs and symptoms in 2011 than trees without captures (Table 2).

Percent crown dieback was significantly positively correlated with the number of EAB captures ($r = 0.25$, $P < 0.001$).

Discussion

The results demonstrate that these trees are not necessarily resistant to EAB infestation, but some have resilience to attack. Thirty-one percent of trees assessed in 2011 had no signs or symptoms of EAB attack. The remaining 69% of trees with signs and symptoms in 2011 still had a median vigor rating of 1, suggesting these trees were under attack by EAB (signs and symptoms) but may be resilient with healthy vigor and low crown dieback (5.5%). Other trees remain in a gradient of susceptibility and many will likely succumb to EAB attack. This is evidenced by the presence of signs and symptoms and decreases in health, both in measures of vigor and dieback.

Many of the trees assessed have been potentially exposed to EAB since the pest's introduction. Using a DBH-age model, the mean establishment year for the trees assessed was 1996 (range = 1985-2005), a third of which had estimated establishment years prior to 1995 approximately when EAB was potentially introduced (Frelich 1992, Siegert et al. 2007). The trees that are still alive, with signs and symptoms, act as continuous sources of EAB adults. They may be resilient enough to survive repeated, annual attacks, however, they are providing a reservoir for EAB populations.