**TITLE:** Evaluation and monitoring of ash trees tolerant to long-term exposure to emerald ash borer.

**LOCATION:** Southeastern Michigan and other areas where emerald ash borer has been present for over a decade.

**DATE**: Original submission: October 12, 2010 This report: September 30, 2011

**DURATION**: Year 2 of 2-year project 5/1/11 – 5/31/13 **FUNDING SOURCE:** Base

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**PROJECT OBJECTIVES:**
1. Monitor a previously identified population of over 200 trees in southeastern Michigan that have survived the emerald ash borer epidemic.
2. Evaluate the stages of the emerald ash borer infestation process that are interrupted in trees that tolerate the presence of emerald ash borer.
3. Identify addition tolerant trees in core areas of emerald ash borer infestation.

**JUSTIFICATION**:

a. **Linkage:** Forest health monitoring has worked to identify emerald ash borer infestations over the last few years. The information from these efforts has led to the detection of emerald ash borer in areas where it has been established for extended periods of time. Trees have been identified in these areas that have survived the emerald ash borer epidemic.
b. **Significance**: This project has significance for all areas where emerald ash borer occurs and where it is likely to occur in the future. This includes all parts of the United States with susceptible hosts. The presence of surviving ash trees and the evaluation of these trees is essential to the long-term management of ash species.
c. **Biological impact and/or political importance of the issue:** Biological impact is high as the presence of tolerant ash trees alters the long term management of ash resources.
d. **Scientific Basis/Feasibility**: Over 200 tolerant ash trees have been identified to date. Preliminary data showing that tolerant ash trees have smoother bark than trees that have succumbed to emerald ash borer have been collected and methods for working with emerald ash borer in field experiments have been established. Therefore the feasibility of this project is very high and it is grounded with a solid scientific basis.
e. **Priority Issues addressed from Request for Proposals:** This proposal includes a number of priority issues including filling data gaps for risk models since not all ash are at the same risk of mortality, and deviations of tree mortality from expected norms. Emerald ash borer is a key invasive species that is currently being managed under the assumption that all trees die once an infestation has run its course.

**DESCRIPTION:**
**a. Background**: A previous forest service funded project has identified over 200 surviving ash trees in the core area of infestation in southeast Michigan. These trees are located in parks managed the Huron-Clinton Metropolitan Authority. Comparison of these surviving trees with trees that have succumbed to emerald ash borer has identified bark roughness as one of the key differences between surviving and dead/dying trees. Trees that have persisted have smoother bark than trees that have died or will die from

emerald ash borer infestation. Of the surviving trees, approximately 2/3 exhibit symptoms of emerald ash borer attack including old attacks that the tree has calloused over. The remaining 1/3 have no symptoms of attack. We view the surviving trees as a significant resource given that emerald ash borer has been active in this area for over 20 years. Collaborators on other projects are also interested in using these trees in their work, and we are cooperating fully with these projects.

**b. Methods:**

**1. Monitor a previously identified population of over 200 trees in southeastern Michigan that have survived the emerald ash borer epidemic.**
We will establish annual revisits to surviving ash trees previously identified in southeastern Michigan to assess canopy condition of trees and evaluate symptoms of emerald ash borer infestation. Long term monitoring of these tree will be essential to confirm that they are not simply escapes that eventually become infested with EAB.

**2. Evaluate the stages of the emerald ash borer infestation process that are interrupted in trees that tolerate the presence of emerald ash borer.**
We will conduct a series of experiments on the trees we have already identified as tolerant of emerald ash borer. Note that scions have already been collected from these trees for propagation work by collaborators. The goal of our experiments is to determine the extent to which the various phases of infestation are interrupted in tolerant and susceptible trees. We will compare landing of adults (rates and patterns) between these tolerant and susecptible trees by placing sticky bands around the stem and monitoring landing over time. We will compare oviposition (rates and locations) by caging pairs of beetles onto trees and then conducting timed visual egg surveys. We will determine the number and location of eggs laid on each tree. We will compare entry of larvae into trees and larval development and survival on trees by placing eggs at known locations on trees (marked with a white paint spot one inch above the egg). A subset of these will be dissected after one month to determine whether larval entry into the tree was successful. The remainder will be dissected after 9 months to determine the developmental stage and survival of the larvae. In addition to this experiment in which we place eggs on trees (and therefore will control for location in relation to bark architecture) we will attempt to follow eggs laid in the oviposition experiment using similar techniques. This will help to verify the validity of our more manipulative experiment.

**3. Identify addition tolerant trees in core areas of emerald ash borer infestation.**
To identify tolerant trees, we visit sites that have significant ash resources. Where necessary we conduct flights for aerial survey to add to our existing database of tolerant trees. We collect imagery of the bark of tolerant and susceptible trees to characterize their roughness, and conduct case-control studies where tolerant trees are compared with the nearest dead or dying trees. We will combine aerial survey with ground data collection as we have done previously. As we develop addition databases of surviving trees, this work will provide additional trees for our other experiments. Data from these studies will be made available to other researchers working on tolerance of ash to emerald ash borer.

**c. Products:**
Product 1: Database of tolerant ash trees and their condition in 2011 and 2012. This builds on their condition in 2009 when these trees were identified. Trees will be added to this database over time.

Product 2: Information about which stage of the infestation process is interrupted in tolerant trees. This will enable testing of ash trees for tolerance to EAB. For example, if landing is interrupted, landing rates on trees can be used to evaluate which trees are likely to tolerate the epidemic. Other examples would be screening trees for oviposition, larval establishment or larval development.

Incorporating these products with those from other studies, we envisage a management flowchart that starts when EAB is discovered in an area, and ends when appropriate management has identified trees that were likely to survive and tools to slow the rate of mortality of the other ash has been implemented.

**d. Schedule of Activities:**

Winter/Spring 2011-2012. Evaluate 2011 results and make database of tolerant ash available. Design 2012 field experiments.

Summer 2012: Conduct field experiments to challenge tolerant trees using current populations of trees and those developed in 2011.

Fall 2012: Evaluate field experiments

Winter 2011-2012: Compete dissections from field experiment to determine larval development and survival. Analyze and write up results.

**e. Progress/Accomplishments:** Note: Funding was not available until August 2011. However, we were able to make significant progress on all three objectives

**Objective 1:** Ash trees were revisited within Kensington, Lake Erie, Lower Huron, Oakwoods, and Willow Metroparks in southeastern Michigan (Oakland and Wayne Counties) that had previously been identified as tolerant of emerald ash borer. Of those 243 trees (including 50 added in 2011), 24 trees that were assessed in 2010 were dead in 2011. Trees that died by 2011 had significantly greater percent dieback (56.7% [SE 5.6]) in 2010 than those trees that survived into 2011 (17.2% [SE 1.4]) ($t_{(1),191} = -9.26$, $P < 0.001$). Of trees that were dead in 2011, 83.3% had a vigor rating worse than 2 (relatively healthy with occasional large dead branches in upper portions of the crown, some small dead twigs in the top of the crown, and foliage density is below normal) in 2010. Only 23.1% of trees that survived into 2011 had a vigor rating worse than 2 in 2010. Trees that died by 2011 also had higher occurrences of EAB symptoms and signs in 2010.

**Objective 2:** All trees that identified in 2010 and alive in 2011 were wrapped with a plastic band (0.5 m wide), coated in Tanglefoot, and centered at breast height to determine adult landing rates throughout the flight seeason. Those trees that captured zero EAB adults had significantly lower percent dieback (13.5% [SE 1.9] vs. 33.8% [SE 3.8], $t_{(1),217} = -5.30$, $P < 0.001$) and fewer percent occurrences of signs and symptoms of emerald ash borer. Also, capturing emerald ash borer (presence or absence on the trap) was not independent of vigor ratings as 81% of trees with were high vigor (rating 1) did not catch any EAB compared with 49% of trees with a lower vigor rating (>1). Percent crown dieback was significantly correlated with the number of EAB landing on the trap ($r = 0.25$, $P < 0.001$). This suggests that tree condition in areas that have had long-term exposure to EAB is a good indicator of likelihood of visitation by EAB.

**Objective 3:** Fifty new trees were found, assessed and added to the study in Kensington (43) and Oakwoods (7) Metroparks. Eighty percent of the new trees were green ash and the remaining 20% were white ash. We will add to this database in 2011.

**COSTS:**

| Item | Year 1 FHM | Year 1 MTU | Year 2 FHM | Year 2 MTU |
|---|---|---|---|---|
| Personnel and fringes | 41,909 | 20,886 | 41,909 | 20,886 |
| Supplies | 2,000 | | 2,000 | |
| Travel | 7,000 | | 7,000 | |
| Overhead (10%) | 5,091 | 35,114 | 5,091 | 35,114 |
| Total | 56,000 | 56,000 | 56,000 | 56,000 |

Personnel: 1 graduate student, faculty summer support and undergraduate field assistants. Supplies include those for the fieldwork and sampling. Travel covers travel to field sites and travel to the annual FMH Work Group Meeting. Costshare is in the form of academic year salary of the PI and waived overhead from the normal rate of 56%.