

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. In each experiment we will consider three populations of trees of each species (where available). These populations will be susceptible trees (those with declining canopies and evidence of EAB infestation), tolerant trees with signs of previous EAB infestation and tolerant trees with no signs of infestation. We will compare landing of adults (rates and patterns) between these populations of 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. This is a standard research procedure in medical research and enables us to compare the characteristic of a surviving tree (in this situation a 'case' tree) with those of the dead or dying tree (in this situation a 'control' tree). 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. We have already provided scions from the tolerant trees to Jennifer Koch of the Forest Service in support of her work on ash resistance to emerald ash borer. We have already reported our work on surviving ash at a number of venues including the annual invasive species forum at Annapolis, MD and the black ash symposium in Bemidji, MN. We will continue to advertize our findings, aiming at the scientific community and the land management and policy community.

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. The results of our evaluation of surviving trees can be utilized in emerald ash borer preparedness plans that are being developed in multiple states and in more local situations.

d. Schedule of Activities:

Summer and Fall 2011: Identify additional tolerant ash. Characterize landing behavior on tolerant and susceptible ash trees.

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: NA

COSTS: Note – this budget estimate has not been approved by Sponsored Programs at Michigan Tech.

Item	Year 1 FHM	Year 1 MTU	Year 2 FHM	Year 2 MTU
Personnel and fringes	41,967	21,844	41,967	21,844
Supplies	2,000		2,000	
Travel	7,000		7,000	
Overhead (10%)	5,097	34,221	5,097	34,221
Total	56,064	56,065	56,064	56,065

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 54%.