USING GIRDLED TRAP TREES EFFECTIVELY

FOR EMERALD ASH BORER

DETECTION, DELIMITATION & SURVEY

Michigan State University
Michigan Technological University
USDA Forest Service, Forest Health Protection

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Michigan Dept. of Agriculture
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Using Girdled Trap Trees Effectively for Emerald Ash Borer Detection, Delimitation and Survey

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Introduction

Emerald ash borer (EAB) (Buprestidae: *Agrilus planipennis* Fairmaire) is an exotic pest of ash (*Fraxinus* spp.). Feeding by the larval stage of this beetle occurs in tunnels called galleries that are excavated in the inner bark and phloem. The galleries created by feeding larvae affect the ability of trees to transport food and water. Low densities of EAB have little effect on the health of a tree. However, when EAB populations increase, the canopy declines, branches die and eventually the entire tree dies. Trees ranging from 1 inch to more than 60 inches in diameter have been killed by EAB.

Ash trees with relatively high densities of EAB larvae are likely to have visible signs of infestation. These external symptoms include thin crowns, vertical bark splits above galleries, dead and dying branches and epicormic sprouts on the trunk or large branches. D-shaped exit holes left by emerging EAB adult beetles can sometimes be found. Woodpecker holes on the trunk or large branches of an ash tree are often the first indication of an EAB infestation.

In contrast, it can be incredibly challenging to find new EAB infestations or to identify trees with low densities of EAB. Newly infested trees often appear healthy and have no external symptoms of EAB infestation. A few D-shaped exit holes may be present, and on small trees (< 4-8 inches DBH) they may be on the trunk and fairly easy to find. On larger trees, however, galleries are usually in the upper canopy for the first couple of years. Often this means that you must climb up into the canopy to see those exit holes.

Using Trap Trees

Several studies conducted by MSU and USDA Forest Service scientists since 2003 have shown that EAB beetles are attracted to stressed ash trees and tend to lay more eggs on stressed trees than on healthy trees. Girdled trees, called trap trees, are currently used for EAB detection and survey in many states.

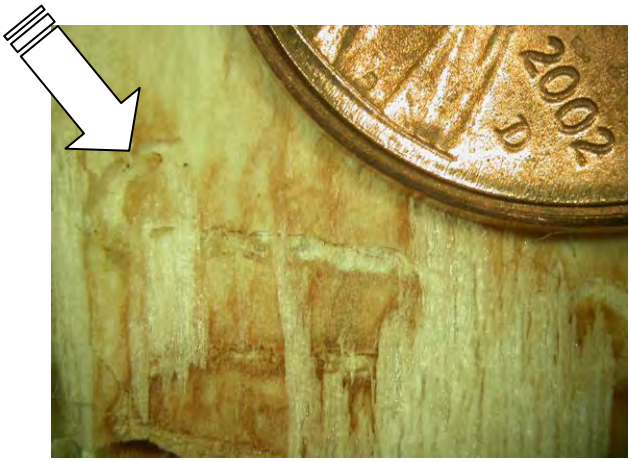
Girdling, or removing a band of bark and phloem around the trunk of a tree, interrupts the ability of the tree to transport carbohydrates – the food needed by the tree. Girdled trees become

increasingly stressed over the summer. As stress increases, the chemicals emitted from the foliage, bark or wood of the tree change. The wavelengths of light reflected by the leaves (hyperspectral reflectance) also differ between healthy and girdled trees. Beetles can apparently detect these changes and are often more attracted to the stressed trees than to surrounding or nearby ash trees.

Recent studies by MTU and MSU scientists have shown that many ash trees can survive for at least two years after girdling. These trees are, of course, highly stressed and may be even more attractive to EAB beetles than trees girdled for only one year.

Debarking Trap Trees – Helpful Hints

WHY DISSECT TRAP TREES IN AUTUMN? Trap tree dissections usually don't begin until September. This is because EAB eggs hatch in July and early August so most larvae don't start feeding until late July or August. As they feed and grow, the galleries lengthen and become more apparent. By late September, most larvae will be 4th instars – the largest stage. Large galleries are obviously easier to find than small galleries.



GALLERIES MAY BE SMALL! Keep in mind, however, that some larvae require two summers of feeding to complete their development. This two-year life cycle seems to be most common in healthy ash trees that have relatively few EAB larvae. Two-year larvae usually spend the first winter as first or second instars, instead of prepupae. These are tiny larvae with very small galleries that are often less than two inches in size. These are the galleries that you want to find when you're surveying for new infestations!

DEBARK SUSPICIOUS AREAS OF THE TREE. When you approach a trap tree, look it over carefully. Look for dying branches, bark cracks, evidence of epicormic shoots or other signs that could be associated with an EAB infestation. When you have a relatively small tree with mostly smooth bark (e.g. most white ash trees), pay extra attention to where the bark is rough, cracked or "rippled". Those areas are often near branch crotches and they may be a good place to find EAB larvae.

PLAN AHEAD WHEN DROPPING TREES. When you fell a trap tree, make it easy on yourself. Try to leave a knee-high "hinge" or set the top of the tree on a sawhorse so that you can debark it while standing up. If the tree is laying flat on the ground, it's hard on your knees and it's difficult to peel bark from the sides of the tree.

BE PATIENT! When you use your drawknife, try to peel the phloem in thin sections, to avoid missing small larvae. Be patient - small larval galleries may be shallow and only present in the upper layer of the phloem. If you peel too deeply, you may not even see them. On the other hand, some small larvae seem to chew nearly straight down to the sapwood before they start to make S-shaped galleries. Be sure to peel the phloem all the way down to the wood. Try to peel areas around branch crotches or anyplace that has relatively rough or fissured bark. It's more difficult to remove bark from those areas but female beetles seem to like rough texture or cracks and crevices for egg-laying.

OTHER INSECTS GET INTO ASH PHLOEM TOO. Other insects will occasionally be found under the bark in ash trees. Larvae of bark beetles (family Scolytidae), round-headed borers (family Cerambycidae), caterpillars (moth larvae) and little maggots (fly larvae) will also feed on ash phloem or wood. Sometimes it can be difficult to distinguish between these insects and EAB. If you are not sure, try to collect the insect and show the gallery to a supervisor or someone with plenty of experience.

Factors to Consider When Selecting Trap Trees

We don't fully understand how beetles select their host trees and how females select areas on a tree for egg-laying. The beetles probably respond to several tree characteristics, including stress. There are, however, some general traits we have observed in our studies that may help you select trap trees or locate galleries when you debark trap trees.

STRESS: Stressed trees that have been girdled, or are otherwise injured or diseased, are consistently more attractive to EAB than healthy trees. Volatile chemicals (compounds that are released into the air) emitted by ash leaves or the wood and bark are different on stressed and healthy trees; hyperspectral reflectance changes and defensive chemicals in the leaves or phloem may be affected by stress.

TREE SPECIES: Beetles seem to demonstrate a preference for some ash species over others. For example, when green ash (*F. pennsylvanica*) and white ash (*F. americana*) trees are growing together, the green ash trees usually have higher EAB densities and decline faster than white ash trees. Green ash and black ash (*F. nigra*) appear to be highly preferred by EAB. White ash is less preferred and blue ash (*F. quadrangulata*) is least preferred. This may be related to differences in leaf, wood or bark chemicals, physical traits like bark texture, or the quality of foliage or phloem. When multiple ash species are available to use as trap trees, it's best to select the tree species most likely to be attacked by EAB.

We recommend selecting ash trees for use as trap trees in this order:

1) Green ash (most preferred);

2) Black ash;
3) White ash;
4) Blue ash (least preferred).

GROWING CONDITIONS: Whenever possible, try to select trees that are growing in the **open** and are fully exposed to the sun. We know that beetles are attracted to light and are more active in sunny, warm locations. Beetles may also be better at detecting the volatile chemicals released into the air by ash leaves, bark or wood when the trees are out in the open. Plus, open-grown trees may simply be more apparent when beetles are looking for hosts. Trees that are shaded or partially shaded, overtopped or in dense forest stands or woodlots are less likely to be attacked by EAB than open-grown or exposed trees.

We recommend selecting trap trees in the following locations:

1) Open-grown trees (e.g. along a roadside or in a field) (most preferred);
2) Hedgerow trees (e.g. at least 2-3 sides mostly open);
3) Edge trees (e.g. trees along the edge of a woodlot, crown exposed on 1-2 sides);
4) Closed canopy trees (least preferred).

BARK TEXTURE: Female beetles seem to prefer laying eggs in bark cracks or crevices and are less likely to lay eggs on smooth sections of bark. When we debark lightly infested trees, we often find most larval galleries are located near branch crotches or other areas that have cracks or "ripples" in the bark.

TREE SIZE: Tree size does not seem to strongly affect EAB host selection, so we generally select trap trees based on practical considerations. Choose trees that are at least 4 inches DBH, so they won't break in the wind after girdling. Avoid using trees that are more than 10-12 inches DBH – bigger trees are more difficult to fell, debark and remove. Avoid trees that are overtopped by larger trees whenever possible.

SAFETY & HAZARD TREES: Avoid trees that could cause damage or injury if they break. Trap trees should be at least two times their height away from campsites, picnic tables, frequently used trails, or other features that could be damaged by a falling tree.

Girdling Trap Trees

HOW TO GIRDLE TRAP TREES: Use a drawknife, pruning saw, chainsaw or other tool and make two parallel cuts, about 4-8 inches apart. Each cut should completely encircle the trunk. Cut through the phloem and down to the wood on each cut. Then use your drawknife, saw or chisel to remove the bark and phloem in the space between the two cuts. Try to get all the way down to the sapwood. Young, vigorous ash trees will sometimes begin to callus over the girdle during the summer. This reduces the level of stress and presumably makes the tree less attractive to EAB.

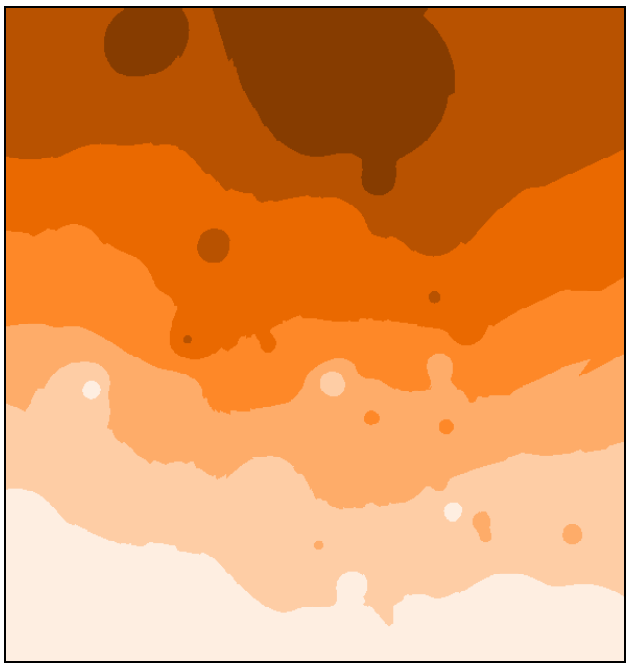
If you cut into the sapwood, you will disrupt xylem cells that transport water. This will increase the stress on the tree and can cause the trap tree to die by the end of the summer. If the tree will be used as a trap tree for two years, it's best to avoid cutting into the sapwood all the way around.

Note: Wounding the tree by removing bark on one side or half of the tree, etc. does not seem to attract beetles as well as a complete girdle.

TIMING: Trees can be girdled in the fall, winter or spring. Don't wait until too late in the spring to girdle trees, however. You want the tree to be sufficiently stressed by the time EAB adults are active and laying eggs. If you plan to girdle trees in spring, try to have the girdling completed by early June, so that trees are stressed by the peak activity period for EAB. Fall girdling can be more difficult than spring girdling because the bark does not separate easily from the wood. You may want to carry a chisel or similar cutting tool to help remove the bark and phloem between the two cuts.

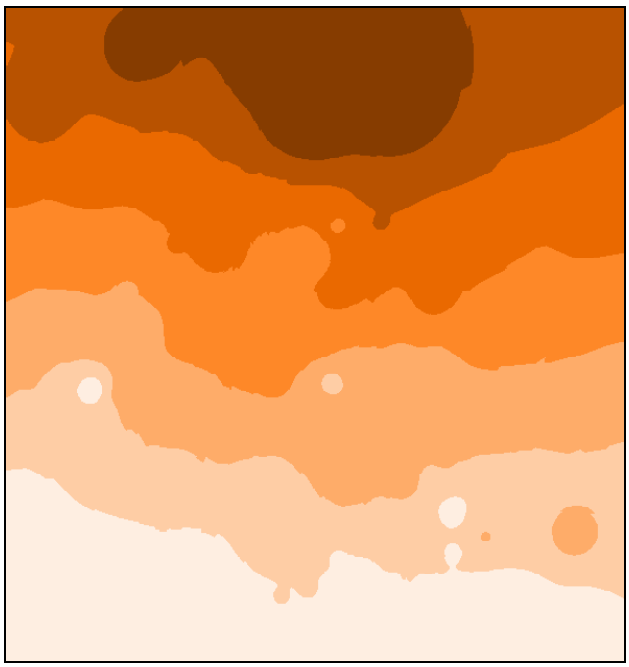
In southern Michigan, EAB adults begin to emerge between mid to late May and early June. Adult EAB are most common and active in late June and early July. If you have access to degree day measurements, EAB emergence usually begins around 450 to 500 degree days, base 50°F. Peak activity, when beetles are most abundant, occurs around 1000 degree days, base 50°F. Up-to-date degree day accumulations for many locations in Michigan and surrounding areas can be accessed through the MSU IPM web site at: http://www.enviroweather.msu.edu/home.asp

EAB Emergence Begins around 450 Degree Days



Calendar dates by which 450 growing degree day thermal units (base 50°F) are reached in the Lake States. Estimates are based on an interpolation of average seasonal daily accumulations (calculated by the Baskerville-Emin method) at 92 locations throughout the region, 1971 to 2000.

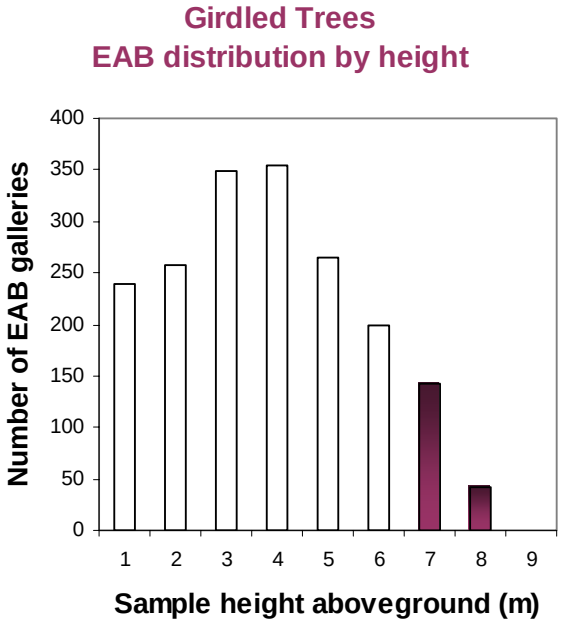
EAB Activity Peaks around 1000 Degree Days

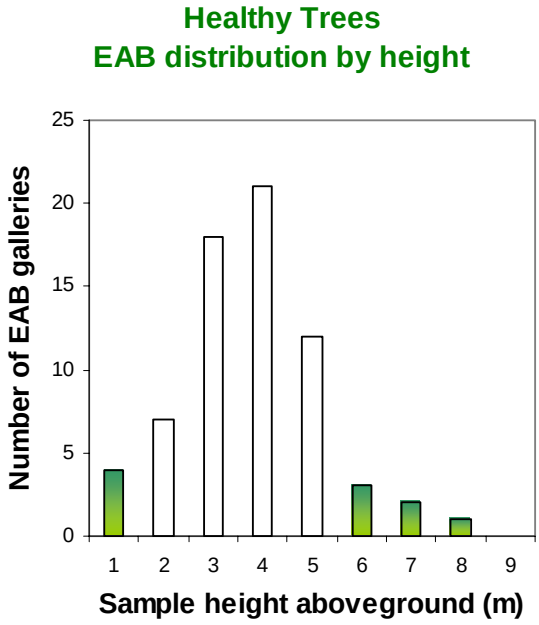


Calendar dates by which 1000 growing degree day thermal units (base 50°F) are reached in the Lake States. Estimates are based on an interpolation of average seasonal daily accumulations (calculated by the Baskerville-Emin method) at 92 locations throughout the region, 1971 to 2000.

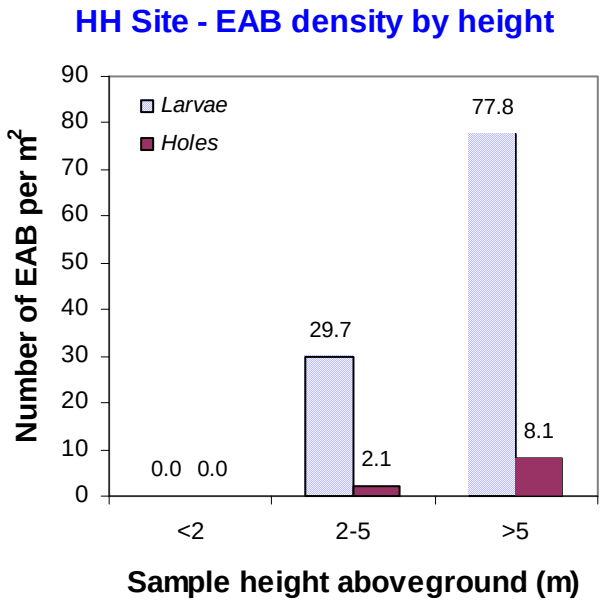
Finding EAB on Newly Infested Trees

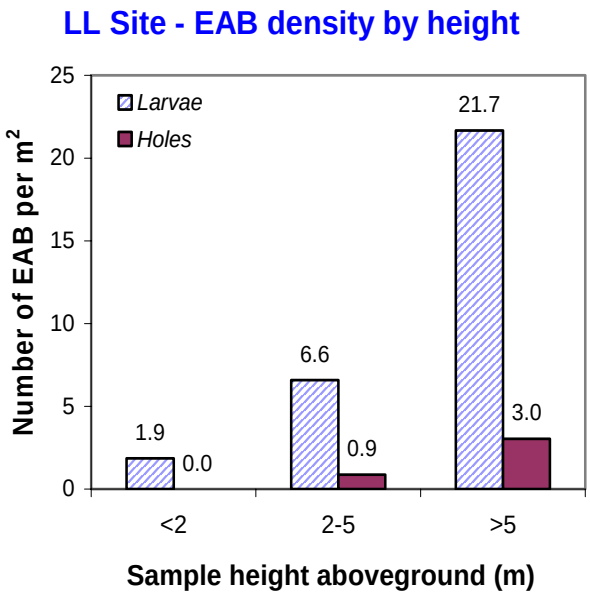
On relatively small ash trees (e.g. ≤ 4-8 inches in DBH), most exit holes and larval galleries will be found on the trunk. For example, in 2006-2007, we felled 30 girdled and 30 healthy ash trees in a plantation with a relatively recent EAB infestation. The trees were 3.5 to 8 inches in DBH. We cut each tree into 1 meter long sections (1 m = 39 inches) and counted the number of galleries on each section. Overall, the girdled trees had 25 times as many galleries as the healthy trees. On the healthy trees, with a low EAB density, 75% of the galleries were 2 to 4 meters aboveground. On the girdled trees, EAB density was high and beetles had to compete for space. Even so, nearly 40% of the galleries were 2 to 4 meters aboveground (6 to 12 ft).





On large trees, however, EAB exit holes and galleries are usually present in the canopy before the trunk becomes infested.





These figures show the density of EAB larvae and D-shaped exit holes for large ash trees sampled at two different sites in late autumn in 2004. "Holes" refers to D-shaped exit holes left when adult beetles emerged in 2003 or in the summer of 2004. "Larvae" refers to the number of larvae feeding in autumn 2004.

You can see that most of the D-shaped exit holes that were present in 2004 were high in the canopy – above 15 ft. We did not find any exit holes on the trunk from the ground to 6 ft aboveground. Even in 2005, most of the EAB exit holes would have been at least 15 ft aboveground on these large trees.

In Conclusion

When EAB was discovered in North America in 2002, very little was known about its general biology. Since then, university and government scientists have learned much about the life cycle, host preference and population dynamics of EAB. Results from many studies were used to develop the recommendations provided here. Research is still progressing, however, and every year we learn more about this invasive pest. We expect to continue to incorporate new information into recommendations to ensure that girdled trap trees are used as effectively as possible for the detection, delimitation and survey of EAB populations.