



This presentation is about emerald ash borer, a beetle that feeds on ash trees. It is invasive in the U.S., originating from East Asia.

# Emerald Ash Borer

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Enhanced First Detector Training for New York State

## Emerald ash borer

- Potential impact
- Distribution & pathways
- Life cycle
- Identification
- Hosts
- Signs & symptoms
- What to do if you suspect you find it



## EAB – overview

EAB has killed tens of millions of ash trees in the U.S.

### EAB is a threat to our

- Urban and natural forests
- Home landscapes
- Industry (flooring, furniture, sporting equipment, etc.)
- Tourism

Native to East Asia

First detection in Detroit, MI in 2002

Photos: top Daniel Herms, OSU, and David Cappaert, MSU, Bugwood.org

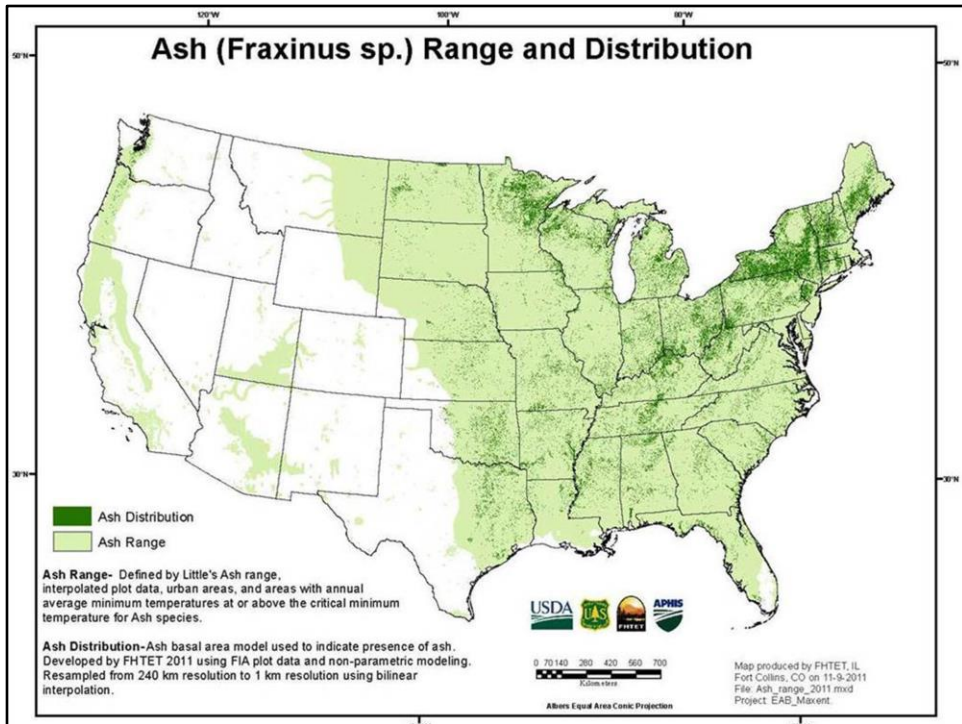


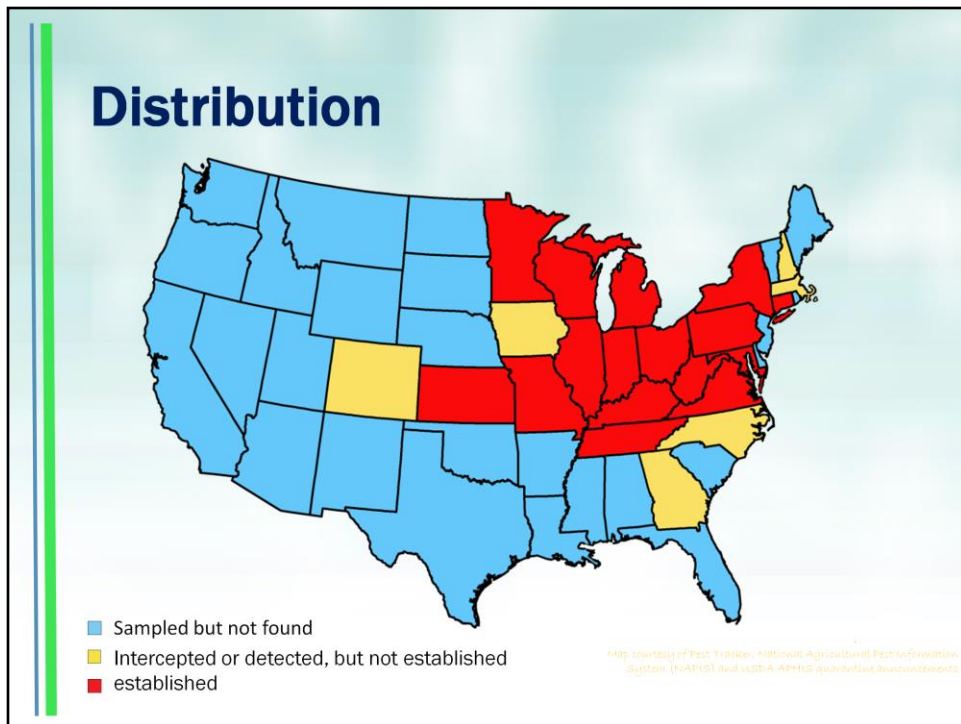
The emerald ash borer (*Agrilus planipennis*) is a wood-boring beetle native to eastern Asia.

Likely introduced in the 1990s it was first identified killing trees in Michigan in 2002. Since then, it has killed tens of millions of native ash (*Fraxinus* spp.) trees in the Midwestern United States and Canada.

The loss of timber value will be small compared to the costs incurred by municipalities, property owners and businesses to treat or remove ash in order to minimize the public health hazard in our communities.

Daniel Herms, The Ohio State University, Bugwood.org





The emerald ash borer is native to East Asia, including China, North Korea, South Korea, Taiwan, Japan, Mongolia, and the Russian Far East.

After the initial detection of emerald ash borer in Michigan in 2002, its distribution has spread within the United States primarily due to human-assisted movement of the beetle by transfer of infested firewood and nursery stock from one area to another.

In the United States, emerald ash borer is known to be established by survey or consensus in the following 16 states: Connecticut, Kansas, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin (shown in red). Infestations are also present in 2 Canadian provinces (Ontario and Quebec).

It has also been intercepted or detected, but is not established, in the following 5 states: Colorado, Iowa, Massachusetts, North Carolina, and New Hampshire (shown in yellow).

Information sources:

National Agricultural Pest Information System (NAPIS). Purdue University. "Survey Status of Emerald Ash Borer - *Agrilus planipennis* (All years)." Published: 12/10/2013.

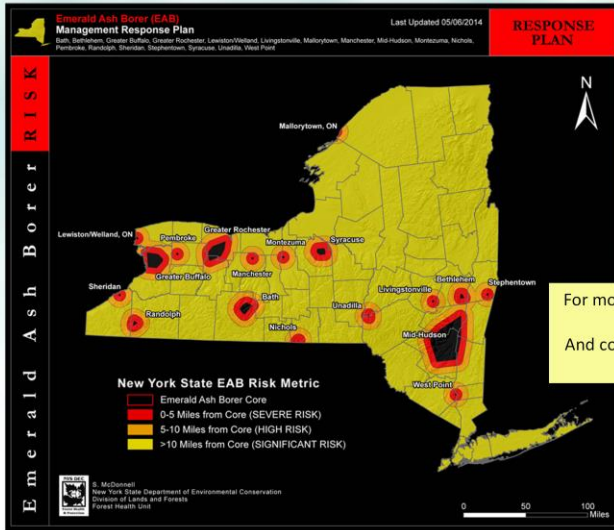
<http://pest.ceris.purdue.edu/map.php?code=INAHQJA&year=alltime>.  
Accessed: 12/13/2013.

Spense, D. and J. Smith. 2011. Emerald ash borer: A potential future threat to ash trees in Florida. EDIS, UF IFAS Extension. Publication # FOR284.  
<http://edis.ifas.ufl.edu/fr346>

United States Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS). 2010. "Emerald ash borer".  
[http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/emerald\\_ash\\_b/background.shtml](http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/background.shtml)

USDA-APHIS/ARS/FS. 2012. Emerald ash borer, *Agrilus planipennis* (Fairmaire), biological control release and recover guidelines. USDA-APHIS-ARS-FS, Riverdale, Maryland.  
<http://www.emeraldashborer.info/documents/EAB-FieldRelease.pdf>

# Potential impact in New York



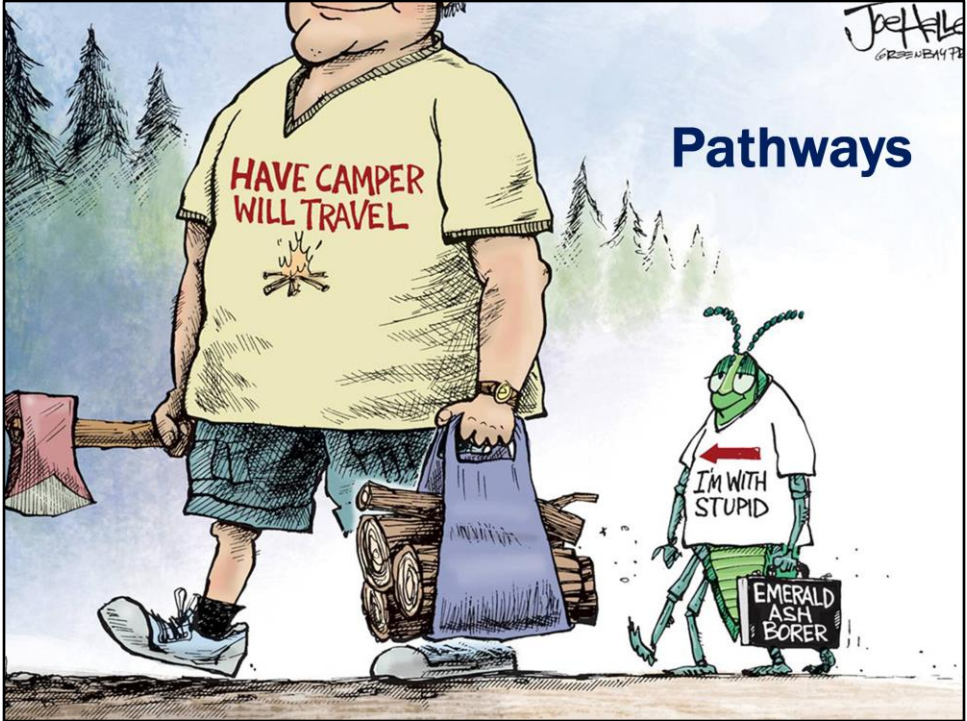
For more information on EAB in NYS visit  
[www.nyis.info/](http://www.nyis.info/)  
And complete the (6) online modules at  
<http://ow.ly/wWvM4>

[www.nyis.info/index.php?action=eab\\_additional\\_general\\_info](http://www.nyis.info/index.php?action=eab_additional_general_info)



Joel Hill  
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# Pathways





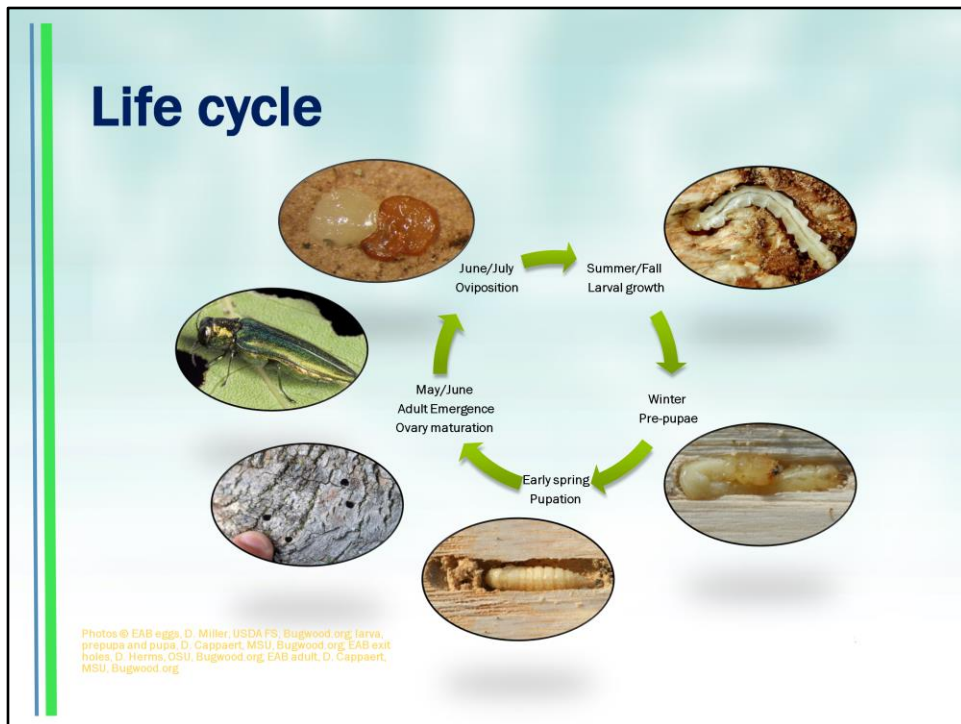
## Pathways

### Artificial spread:

- Movement of EAB in infested firewood
- Movement of EAB in infested logs
- Movement of EAB in infested nursery stock
- Other: articles of transport

### Natural spread:

- Adult flight to susceptible ash trees



Emerald ash borer completes its life cycle in one or two years, depending on temperature and tree health. The information provided here is for a one-year life cycle.

Eggs are laid in the summer after adults emerge. Females may lay 1-23 eggs at a time (one is the norm) and each female may lay approximately 60-100 eggs in her lifetime. Eggs are laid in bark crevices along the trunk and on major branches and hatch within 1-2 weeks.

Newly hatched larvae bore through the bark to the phloem and outer layer of new sapwood. They feed until colder weather in the fall. As they feed, they create long, winding galleries (tunnels) filled with frass. There are four larval instars.

Larvae overwinter under the bark starting in the fall. Mature, fourth instars excavate pupal chambers in the sapwood or outer bark. Larvae fold into a J-shape to overwinter and shorten into prepupae in the spring. They then shed their cuticle to become naked pupae.

Adults – adults emerge in May or June, leaving a characteristic D-shaped exit hole as they chew through the bark. Adults are capable of flight upon emergence (both males and females are strong fliers). They then fly into the canopy and feed on ash leaves. Adults mate 1-2 weeks after emergence (females mate multiple times) and begin laying eggs after approximately 2-3 weeks. They are active on warm, sunny days and may hide in tree crevices otherwise. Adults are short-lived, living approximately 3 weeks.

#### Information sources:

Skelley, P. E., and M. C. Thomas. Pest alert: Emerald ash borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). FDACS DPI.

<http://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Plant-Industry-Publications/Pest-Alerts/Emerald-Ash-Borer>

Spense, D. and J. Smith. 2011. Emerald ash borer: A potential future threat to ash trees in Florida. EDIS, UF IFAS Extension. Publication # FOR284.

<http://edis.ifas.ufl.edu/fr346>

United States Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS). 2010. "Emerald ash borer". [http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/emerald\\_ash\\_b/background.shtml](http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/background.shtml)

USDA-APHIS/ARS/FS. 2012. Emerald ash borer, *Agrilus planipennis* (Fairmaire), biological control release and recover guidelines. USDA-APHIS-ARS-FS, Riverdale, Maryland.

<http://www.emeraldashborer.info/documents/EAB-FieldRelease.pdf>

## Identification

### EAB adults

- 3/8"–5/8" long (males slightly smaller)
- Dark metallic emerald green outer wings (elytra)
- Abdomen metallic purplish red



© Kent Loeffler, Cornell University



© Taylor Scan, Ontario Ministry of Natural Resources, Bugwood.org

Adults are metallic green in color with bronze undertones.

EAB adults are about 1/2" long and 1/6" wide, slightly larger than a tic-tac candy.

EAB adults feed on ash leaves from late May to mid August. After EAB adults emerge from the tree from late May to mid August they mate and then the female will feed on ash leaves for one to two weeks to mature her ovaries prior to egg laying.

Adult beetles are most active during the day and favor sunny, warm weather, sheltering in bark crevices or under foliage when it is rainy, windy or cooler. The life span of adult EAB is about 3 weeks.

## Identification

### EAB larvae

- Flattened, legless
- 1 inch
- White or cream colored
- Nested bell-shaped segments
- Pincer-like appendages on last segment



© PDCI® - Forestry Archive, Baywood.org

Larvae reach a length of approximately 1 inch and are white or cream colored. The body is flattened with nested bell-shaped segments; the brown head is mostly retracted into the body and only the mouth parts are visible externally. The 10-segmented abdomen has a pair of brown, pincer-like appendages on the last segment.

Larvae can be found by stripping the bark from infested branches and trunks.

Larvae create S-shaped galleries as they feed on the cambium that fill with frass (sawdust-like excrement).







## Look-alikes

1. Bronze birch borer (*Agrilus anxius*)
2. Two-lined chestnut borer (*Agrilus bilineatus*)

These borers are similar in size and shape to EAB, but are colored differently and attack different tree hosts.



© Kent Loeffler, Cornell University

Several borers native to North America are closely related to EAB. Two that are also pests of native trees are:

1. Bronze birch borer (*Agrilus anxius*)
2. Two-lined chestnut borer (*Agrilus bilineatus*)

They are similar in size and shape to EAB, but are colored differently and attack different tree hosts.



## Look-alikes

Other insects that resemble EAB include:

Clockwise from top left:

1. EAB
2. Trogossitid beetle
3. Dogbane beetle
4. Common green bottle fly
5. Sharpshooter
6. Sweat bee
7. Japanese beetle
8. Six spotted tiger beetle
9. Green stink bug
10. Green June beetle



© Kent Loeffler, Cornell University

For more information about EAB look-alikes, or to download a look-alikes poster visit:

<http://www.nyis.info/?action=identification>

There are many other green insects which are not related to EAB but because of their green color or iridescence are often mistaken for EAB. Don't be fooled by these EAB look alike.

- Clockwise from top left: (1) EAB
- (2) Trogossitid beetle - *Temnochila virescens*
  - (3) Dogbane beetle - *Chrysochus auratus*
  - (4) Common green bottle fly – *Lucilia sericata*
  - (5) Sharpshooter – *Draeculacephala* sp.
  - (6) Sweat bee - *Augochlorella striata*
  - (7) Japanese beetle - *Popillia japonica*
  - (8) Six spotted tiger beetle - *Cicindela sexguttata*
  - (9) Green stink bug - *Acrosternum hilare*
  - (10) Green June beetle - *Cotinis nitida*

Clockwise from top left:

- (1) EAB
- (2) Trogossitid beetle

- (3) Dogbane beetle
- (4) Common green bottle fly
- (5) Sharpshooter
- (6) Sweat bee
- (7) Japanese beetle
- (8) Six spotted tiger beetle
- (9) Green stink bug
- (10) Green June beetle



Before you can find EAB you must first know how to identify ash trees which are the only trees attacked and killed by EAB in North America. Ash belong to the genus *Fraxinus*. There are 16 species of ash in North America but only three are commonly found in New York.

White ash (*F. americana*) and green ash (*F. pennsylvanica*) are common forest trees and are also frequently planted in urban areas. Black ash (*F. nigra*) is an important wetland species and is culturally important for Native Americans that use the wood for traditional basketry.

Note their upright silhouette, elongated, oval shape.

## Ash tree identification

EAB feed on stressed and healthy ash trees.

All three NY ash (white, green and black) have:

- Opposite branching
- Pinnately compound leaves (5-11 leaflets)
- Large, stout, terminal buds
- Noticeable bud scars
- Oar shaped, dry fruit (samaras)
- Diamond pattern in the bark (white and green ash)



© Robert Vidéki, Doronicum Kft., Bugwood.org

Ash trees are easy to identify and all three of New York's commonly ash trees: white, green and black, share several features.

Ash trees have opposite buds, leaves and branches. Leaves are pinnately compound with one terminal leaflet. Buds are large, stout and leaf scars are distinct. Female ash trees have one winged samaras (similar to maples only with one wing). Green and white ash have bark with a distinct diamond pattern.

## Ash tree identification

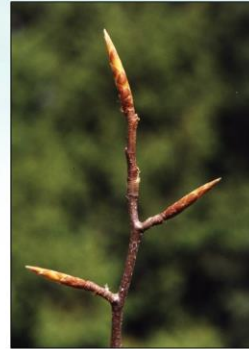
Buds (therefore leaves and branches) grow directly across from each other. Only a few trees in NY have opposite branching: ash, maple and horsechestnut/buckeye.

Opposite, ash



Paul Wray, Iowa State University, Bugwood.org

Alternate, beech



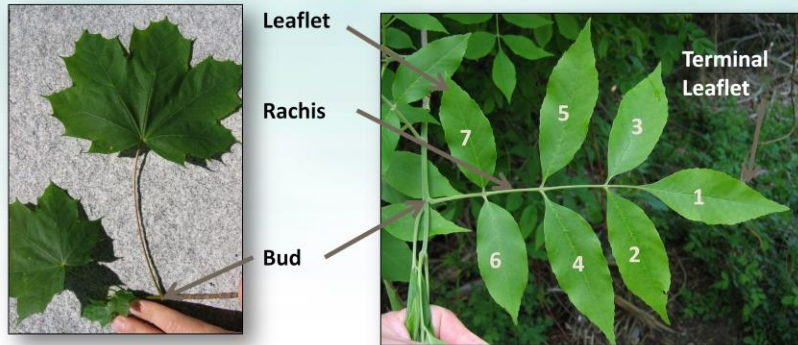
Bill Cook, Michigan State University, Bugwood.org

For a quick review: note the opposite arrangement of buds on the ash twig versus the alternate arrangement of buds on the beech twig.

# Ash identification

Compound leaves: leaves made up of multiple leaflets.

Pinnate: Leaflets arranged linearly along a rachis (stem)



The location of the bud determines whether it's simple or compound- the bud is always at the base of the leaf.

Simple on left (Norway maple) Compound on Right (green ash)

Compound leaves: leaves made up of multiple leaflets.

Pinnate: Leaflets arranged linearly along a rachis (stem)



## Ash identification

Ash fruit a single samara: seed surrounded by dry, oar shaped wing that helps with dispersal.



© Keith Kanoti, Maine Forest Service, Bugwood.org

Only female ash trees will have fruit...

# Ash identification

On-line resources for ash identification

Know Your Trees:

<http://ecommons.cornell.edu/bitstream/1813/86/2/art.pdf>

CU Woody Plant Database:

<http://woodyplants.mannlib.cornell.edu/>

Virginia Tech Dendrology:

<http://cnre.vt.edu/dendro/dendrology/main.htm>



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We also recommend carrying around a couple of your favorite tree identification books.



## Signs & symptoms

**Symptoms** are host responses to pest infestation.

**Signs** are physical clues of a pest that are unrelated to host responses to the pest.

Signs can include the various stages of the insect.



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It can take two or more years for an infested tree to show noticeable signs or symptoms of EAB attack. At the beginning of an infestation when beetle populations are low the trees take years to display symptoms. When beetle numbers are high and the number of trees infested is high, symptoms will be evident more quickly and tree death can occur in as little as a couple of years.

## Signs & symptoms

- Woodpecker foraging
- Vertical bark cracks
- Canopy decline
- Epicormic sprouts
- D-shaped exit holes
- S-shaped larval galleries
- Adult beetles feeding on leaves



© Daniel Herms, The Ohio State University, Bugwood.org

**Ash with signs & symptoms will not be found singly,** neighboring trees will also be affected. So look closely at all nearby ash when you find a suspicious tree.



## Woodpecker foraging

Fresh bark flaking – easiest to see when wet

- Look for the light brown color of freshly flaked bark.
- Look for holes where the woodpecker has found a prey.

### How deep is the foraging

- Are they foraging deep in the wood or remaining in the bark?
- Are they foraging in sound wood or punky, rotten wood?

### Pattern of foraging

- Dispersed in checkerboard manner
- Large swaths of freshly flaked bark
- All in a line and old = not EAB

© Ethan Angell, NYSDAM

It doesn't take long for woodpeckers to learn that EAB can be found under the bark of ash trees. Usually before any canopy symptoms are present you can find signs that woodpeckers have been feeding on EAB.

At first there are just a few places where you can find the bright brown bark exposed and a spot where the woodpecker has reached in the bark to pull out an EAB. These are usually dispersed around the trunk in a checkerboard-like pattern. As EAB populations increase the bark will be more thoroughly removed from larger areas and can be easily seen from a distance, especially when the bark is wet.

## Signs & symptoms

### Bark cracking



Photos from left: PDCNR-Forestry Archive and Michigan Department of Agriculture, Bugwood.org

This is the earliest sign of EAB infestation. This occurs when the first EAB attacks are few and far between on the stem of an ash. The bark is killed above the spot where the EAB have fed, but the surrounding inner bark is perfectly healthy and the tree continues to grow. With low PP it can take years for EAB populations to build to the point where they are killing trees. Every year the tree grows after the initial attacks the areas of dead bark will split wider and wider and the EAB gallery beneath can be seen.

Michigan Department of Agriculture, Bugwood.org

## Signs & symptoms

### Canopy thinning

Usually by the time canopy thinning is noticed the trees have suffered considerable loss of inner bark and will be unable to recover using pesticide treatments.



Photos from top: Eric R. Day, Virginia Polytechnic Institute and State University, Bugwood.org and Mark Whitmore, Cornell University

Canopy thinning can take years to become apparent at the beginning of an infestation when the PP is low. Canopy thinning is caused not so much by branches dying, but by the general leaflet size decreasing because EAB has cut off the flow of nutrients for full leaf-out.



# Signs & symptoms

## Epicormic sprouting



© PDCNR, Forestry Archives, Bugwood.org



© PDCNR, Forestry Archives, Bugwood.org

**Epicormic**, or water, sprouting is a response by the tree to fill out canopy that has been lost by some physical means such as EAB killing the upper parts of a tree. Green ash are strong sprouters, whereas white ash produce fewer and less vigorous sprouts.

By the time **epicormic** sprouting appears the trees have suffered considerable loss of inner bark and will be unable to recover using pesticide treatments.

## Signs & symptoms

D-shaped exit holes



D-shaped exit hole and wood pecker damaged hole





When you see woodpecker foraging on a tree and perhaps some bark cracks then chances are closer examination will reveal the "D" shaped holes adult EAB make as they chew their way out through the bark. These can be small, usually only 3 to 4 mm wide.

When you peel away the bark of an ash infested with EAB their typical "S" shaped galleries. Even when EAB densities are very high and most of the galleries are obscured closer examination will reveal signs of this typical gallery shape.



# EAB identification summary

## **Emerald Ash Borer:**

- Adults are metallic green and about ½” long. They are active from May-August.
- Larvae are found beneath the bark, have bell shaped segments and a tiny, flattened head.

## **Ash Trees:**

- Opposite branching with pinnately compound leaves
- A distinct diamond-shaped pattern in mature bark
- Oar-shaped seeds (samaras) that hang in clusters

## **Infestation signs & symptoms:**

- Splitting of the bark
- Woodpecker foraging on trunk
- S-shaped feeding galleries beneath the bark
- D-shaped exit holes
- Canopy thinning and branch dieback in tree canopy
- Epicormic shoots at base of tree



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## Monitoring and management

Prevention is critical!

### Monitoring:

Detection of infestation symptoms; use of panel traps

### Cultural control:

Regulation of movement of ash wood materials; removal of infested trees



Prevention is critical because control of any wood boring-insect is very difficult, once established. People are accelerating the spread of EAB by transporting infested ash articles.

Monitoring activities include looking for symptoms of infestation (specimens are needed for confirmation of identity) and using survey detection tools such as sentinel trees and panel traps.

Cultural control strategies include regulating movement of firewood, nursery stock, and other ash wood materials in infested areas and removal of infested and dead trees to protect uninfested trees.

Information sources:

Skelley, P. E., and M. C. Thomas. Pest alert: Emerald ash borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). FDACS DPI.

<http://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Plant-Industry-Publications/Pest-Alerts/Emerald-Ash-Borer>

Spense, D. and J. Smith. 2011. Emerald ash borer: A potential future threat to ash trees in Florida. EDIS, UF IFAS Extension. Publication # FOR284.

<http://edis.ifas.ufl.edu/fr346>

United States Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS). 2010. "Emerald ash borer".

[http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/emerald\\_ash\\_b/background.shtml](http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/background.shtml)

## Look-alike

Emerald ash borer, *Agrilus planipennis*, feeds on ash trees. Report either of these pests.

The oak splendor beetle, *Agrilus biguttatus*, is a econdary pest that feeds on oak trees. It is not known to be in the US.



Photos: Kent Loeffler, Cornell University

The oak splendor beetle, *Agrilus biguttatus*, is a close relative to the emerald ash borer. It is not known to be established in the US but is of interest to USDA-APHIS. It is an aggressive secondary pest on oaks and is believed to be a contributing to declining oak trees in Europe. Both pests are considered actionable which means they should be reported if you find them. So if you see something which looks very similar to an emerald ash borer but it is on oak trees you should take a picture and send it to our insect diagnostic lab...

## Authors

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### Adapted from these NPDN EAB presentations

Enhanced First Detector Training for Florida  
EAB First Detector Training Modules  
Significant Insects of the Northeast



Enhanced First Detector Training for New York State

# Collaborating Agencies

U.S. Department of Agriculture Animal and Plant Health  
Inspection Service (USDA-APHIS)

Cooperative Agricultural Pest Survey Program (CAPS)

Florida Department of Agriculture and Consumer Services  
(FDACS)

National Plant Diagnostic Network (NPDN)

Sentinel Plant Network (SPN)

Protect U.S.

University of Florida Institute of Food and Agricultural  
Sciences (UF-IFAS)



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