Flatheaded Apple Tree Borer
Buprestidae

- Native metallic wood boring beetle
- Adults - ½”, oval, flattened, metallic greenish bronze above and brassy below
- Larvae - Flat headed borer, white larvae with black head
- Host Plants
  - Preferred hosts include red and silver maple, dogwood, oak, etc.

Bronze Birch Borer
Buprestidae

- Native metallic wood boring beetle
- Adults - 3/8”, narrow bodied with short antennae and legs, grayish black with slight metallic sheen
- Larvae - Flat headed borer, white larvae with black head and 2 posterior spines
Native pest – Native and Exotic plants
Who lives? Who dies?

• Native birches
  - B. nigra
  - B. papyrifera
  - B. populifolia

• Exotic birches
  - B. platyphylla (Asia)
  - B. pubescens (Europe)
  - B. pendula (Europe)

Dead after 7 years (%)
- 0
- 4
- 2
- 100
- 100
- 100
- 100
Life cycle -
- Larvae - overwinter under bark
- Pupae - in spring
- Adults- emerge May to June when black locust blooms
- Adults - feed, mate, fly and lay eggs
- Eggs hatch - larvae enter tree and feed on cambium, phloem, and sapwood

Symptoms of attack by emerald ash borer
1. The upper third of a tree dies back first, followed by the rest the next year.
2. This is followed by many shoots or sprouts emerging below dead portions of the trunk.
3. The canopy continues to decline until the tree eventually dies.

Symptoms of EAB
- Increased woodpecker activity.
“How to tell” signs of Emerald Ash Borer and Clearwing Borers

Emerald Ash Borer
Exit holes D-shaped
No frass or pupal cases

Clearwing Borers
Exit holes round or oval
Frass on bark and ground
Pupal cases

Sure signs of EAB
“D” shaped hole
Emerald Green Beetle

“D” shaped exit hole

IPM Tactics for EAB

- Cultural Controls - Increase plant diversity, install and maintain trees to minimize stress
- Mechanical control - basal pruning
- Resistant Varieties
- Biological Control
- Chemical Control

EAB is so aggressive that reducing stress is unlikely to help
Resistant Plants for EAB Management
Exotic pest – Native and Exotic plants
Who lives? Who dies?

- Native ashes
  - F. pennsylvanica Patmore
  - F. americana Autumn Purple
  - F. pennsylvanica Marshall’s Seedless
- Exotic ash
  - F. mandshurica Mancana

More is now known about ash resistance to EAB

F. quadrangulata and F. mandshurica – relatively resistant
F. americana – intermediate
F. nigra and F. pennsylvanica – susceptible

Sara R. Tanis and Deborah G. McCullough, 2015

Novel Host Plant – White Fringetree

EAB moved to another Oleaceae!

Chionanthus virginicus
D. Cipollini 2014

Parasitoids of EAB

- Oobius agrili adult parasitizing EAB egg
  (photo courtesy of Dr. Leah Bauer).
- Tetrastichus planipennisi adult parasitizing EAB larva
  (photo courtesy of Dr. Leah Bauer).
- Female Spathius agrili ovipositing on EAB through ash bark
  (photo courtesy of Dr. Yang Zhong-qi, Chinese Academy of Forestry).
- Spathius agrili larvae consuming their EAB host
  (photo courtesy of Dr. Yang Zhong-qi, Chinese Academy of Forestry).

Parasitoid Releases

<table>
<thead>
<tr>
<th>Species</th>
<th>2008 - 2010 Per Site (Females)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oobius agrili</td>
<td>700 - 1150</td>
</tr>
<tr>
<td>Spathius agrili</td>
<td>680 - 1100</td>
</tr>
<tr>
<td>Tetrastichus planipennisi</td>
<td>3300- 3680</td>
</tr>
</tbody>
</table>
Egg Parasitism by *Oobius agrili* at the Six Michigan Study Sites

*Abell, Bauer, Duan, Van Driesche. 2014. Biol. Cont. 79: 36-42.

Visual egg search method

Bark sieving method

**Dynamics of EAB Larval Parasitism by Native Natural Enemies on Larger Ash Trees (DBH = 7 – 21 cm)**

Duan et al. 2015 (J. Appl. Ecol. 52: 1246 - 54)

**Atanycolus spp.**

Parasitism Rate (+SE)%

Year of Sampling (Autumn)

**Dynamics of EAB Larval Parasitism by Biocontrol Agents on Larger Ash Trees (DBH = 7 – 21 cm)**

Duan et al. 2015 (J. Appl. Ecol. 52: 1246-54)

**Tetrastichus planipennisi**

Parasitism Rate (+SE)%

Year of Sampling (Autumn)

**EAB Density Adjusted for Live Phloem Area on Larger Ash Trees (DBH 7 – 21 cm)**

Duan et al. 2015 (J. Appl. Ecol. 1246 - 54)

Number of Live EAB Larvae

Mean ± SE (m² Phloem)

Year of Sampling

**EAB-Induced Ash Mortality in the Upper Huron River Watershed, SE Michigan**

Dan Herms, Department of Entomology, The Ohio State University

**Insecticide Options for Protecting Ash Trees from Emerald Ash Borer**


Best source of information on materials to use for controlling EAB
What affects efficacy of insecticides?

- Canopy condition >50% lost success declines
- Interval between applications - emamectin benzoate provides 2 years of protection, imidacloprid and dinotefuran only 1
- Soil moisture - systemics will not enter in dry soils, soil should be moist but not saturated

What affects efficacy of insecticides?

- Mulch may bind imidacloprid soil drenches - move mulch back
- Apply drenches or injections within 18 inches of trunk and 2-4 inches deep
- Apply in mid-April to mid-May depending on region - allow 4-6 weeks for uptake

What affects efficacy of insecticides?

- Efficacy is less consistent on larger trees > 15 inches DBH
- Two applications of Merit (one in spring and one in fall or two in spring) or the highest rate of Xytect may be necessary for trees > 15 inches DBH
Tree-äge rate study: 2 yrs control even at low rate (20-25 inch DBH)

Azadirachtin (Azasol, TreeAzin)

Modes of Action
- Larval stages:
  - Interrupts growth and development (IGR)
- Adult stages:
  - Repellent (e.g., Mountain Pine Beetle)
  - Reduced fecundity & egg viability (e.g., Emerald Ash Borer)

Emerald Ash Borer in Maryland

Part 3: Economic Impact

Sample Inventories
1. Define municipal trees
2. Conduct sample municipal tree inventory
3. Estimate total population size
4. Estimate costs for management
5. Provide details on benefits of ash.

Municipal ash population estimates

<table>
<thead>
<tr>
<th>Municipality</th>
<th>0-3</th>
<th>3-6</th>
<th>6-12</th>
<th>12-18</th>
<th>18-24</th>
<th>24+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annapolis</td>
<td>787</td>
<td>644</td>
<td>429</td>
<td>238</td>
<td>24</td>
<td>24</td>
<td>2146</td>
</tr>
<tr>
<td>Bowie</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>43</td>
<td>86</td>
<td>129</td>
</tr>
<tr>
<td>Upper Marlboro</td>
<td>132</td>
<td>314</td>
<td>149</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>595</td>
</tr>
<tr>
<td>Marland</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2. Estimated annual benefits (in dollars, rounded to the nearest hundred) of municipal ash street tree populations, calculated in i-Tree Streets.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Energy</th>
<th>CO₂</th>
<th>Air Quality</th>
<th>Stormwater</th>
<th>Aesthetic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annapolis</td>
<td>51,800</td>
<td>900</td>
<td>8,700</td>
<td>10,200</td>
<td>81,200</td>
<td>152,800</td>
</tr>
<tr>
<td>Bowie</td>
<td>15,300</td>
<td>400</td>
<td>3,100</td>
<td>4,300</td>
<td>9,000</td>
<td>32,100</td>
</tr>
<tr>
<td>Greater Upper</td>
<td>25,900</td>
<td>500</td>
<td>4,300</td>
<td>4,900</td>
<td>25,500</td>
<td>61,100</td>
</tr>
<tr>
<td>Marlboro</td>
<td>30,600</td>
<td>600</td>
<td>4,700</td>
<td>5,300</td>
<td>30,000</td>
<td>72,800</td>
</tr>
</tbody>
</table>

Note: All street tree values were assessed using the Northeast STRATUM climate zone.

Management Options
1. Define municipal trees
2. Conduct sample municipal tree inventory
3. Estimate total population size
4. Estimate costs for management
5. Provide details on benefits of ash

Table 3. Estimated cumulative costs (in dollars, rounded to the nearest thousand) of management options for street ash tree populations, over 5 and 25 year periods, calculated with the Purdue EAB Cost Calculator 2.0.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Yr</th>
<th>Remove All</th>
<th>Replace All</th>
<th>Treat All</th>
<th>Replace &lt;24&quot;</th>
<th>Urban SLAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annapolis</td>
<td>5</td>
<td>124,000</td>
<td>612,000</td>
<td>149,000</td>
<td>602,000</td>
<td>54,000</td>
</tr>
<tr>
<td>Bowie</td>
<td>5</td>
<td>228,000</td>
<td>1,082,000</td>
<td>924,000</td>
<td>1,081,000</td>
<td>298,000</td>
</tr>
<tr>
<td>Greater Upper</td>
<td>5</td>
<td>104,000</td>
<td>338,000</td>
<td>294,000</td>
<td>338,000</td>
<td>97,000</td>
</tr>
<tr>
<td>Marlboro</td>
<td>5</td>
<td>100,000</td>
<td>338,000</td>
<td>294,000</td>
<td>338,000</td>
<td>97,000</td>
</tr>
</tbody>
</table>

Note: All street tree values were assessed using the Northeast STRATUM climate zone.


Do you feel our pain?

Coleoptera

Cerambycidae – Longhorned Beetle / Round Headed Borers

- All are phytophagous
- Adults - elongate and cylindrical bodies, long antennae, squeak
- Brightly colored adults feed on flowers, dull colored are nocturnal
- Larvae - most are wood boring, very destructive
- Prefer stressed trees; stem borers, twig girdlers, bore into and girdle trunks and branches
Rhododendron Stem Borer
Cerambycidae
• Native longhorned beetle
• Adults – 5/8”; pale yellow with 2 black spots on thorax
• Larvae – round headed borer
• Host Plant
  - Prefers rhododendron but will attack azaleas and mountain laurel

Twig Girdler
Cerambycidae
• Native longhorned beetle
• Adults – ¾”; grey with 2 dark bands across wings
• Larvae – round headed borer; ~ 1”
• Host Plants
  - Hickory, honeylocust, persimmon, elm, oak, poplar, dogwood, linden, flowering fruits
Twig Pruner
Cerambycidae

- Native longhorned beetle
- Adults - ¾”; brown, slender, 2 posterior spines on each wing cover
- Larvae – round headed borer; ~ 1”
- Host Plants
  - Oak, Hickory, ash, maple, honeylocust, elm, linden, sweetgum, persimmon
Status of ALB in US

New York City (1996)
Chicago (1998)
Jersey City (2002)
Toronto-Vaughn (2003)
Carteret, Rahway (2004)
Staten Island (2007)
Clark, Roselle, Elizabeth, Linden, Woodbridge (2006-2007)
Worcester (2008)
Boston (2010)
Ohio (2011-2012)

Active infestations in New York (Long Island), Massachusetts, and Ohio - 2017

Symptoms and signs of ALB Infestation

- Large emergence holes on branches or the stem (>3/8" diam).
- Sawdust accumulates at branch crotches or tree base.
- Flogging & dieback in the canopy.

Sawdust and egg niches

ALB Life Cycle

1. Egg Niche
2. Larva
3. Pupa
4. Emergence Hole
5. Adult

Adult feeding damage

Egg
**IPM Tactics for ALB**

- **Cultural Controls** - reduce plant stress
- **Resistant Plants** - select from the non-host list
- **Mechanical control** - tree removal
- **Biological Control** - search is underway in Europe for parasitoids in related species
- **Chemical Control** - systemic neonicotinoids
- **Regulatory Control** - inspections, quarantines

**ALB Intervention Plan from Clermont County, Ohio, Four Options** - USDA-APHIS

(A) no action by APHIS (quarantine would continue)
(B) removal of infested trees and high risk host trees up to a ½-mile from infested trees (full host removal)
(C) removal of infested trees and imidacloprid treatment of high risk host trees up to a ½-mile from infested trees
(D) infested host removal and combination of removal or imidacloprid treatment of high risk hosts.

**Removal of Infested Trees Ravenswood, Illinois**

Before

After
Removal List – UK

- Acer spp. (maple and box elder)
- Alnus spp. (alder)
- Betula spp. (birch)
- Carpinus (hornbeam)
- Celtis (hackberry)
- Cercidiphyllum japonicum (Katsura tree)
- Corylus (hazel)
- Fagus (beech)
- Fraxinus (ash)
- Koelreuteria paniculata
- Platanus spp. (plane)
- Populus spp. (poplar)
- Prunus spp. (cherry, plum)
- Robinia pseudoacacia (false acacia/black locust)
- Salix spp. (willow, sallow)
- Sophora japonica (Pagoda tree)
- Sorbus spp. (mountain ash, whitebeam etc)
- Quercus palustris (American pin oak)
- Quercus rubra (North American red oak)
- Ulmus spp. (elm)

Removal List - US

- Acer spp. (maple and box elder)
- Aesculus spp. (horse chestnut and buckeye)
- Alnus spp. (alder)
- Betula spp. (birch)
- Celtis (hackberry)
- Cercidiphyllum spp. (Katsura tree)
- Fraxinus spp. (ash)
- Koelreuteria spp. (golden rain tree)
- Platanus spp. (sycamore and London plane)
- Populus spp. (poplar)
- Salix spp. (willow)
- Sorbus spp. (mountain ash)
- Ulmus spp. (elm)

...oak, hickory, beech, and locust are not ALB host species, USDA 2013


Replanting Strategies

- Resistant species
- Diverse plantings

White Pine Weevil

- Curculionidae
- Native conifer weevil
- Adults – ¼”, long snout; 2 white spots that come together on wings
- Eggs – oviposited in terminals
- Larvae – “C” shaped, legless
- Host Plants
  - Prefers Eastern white pine, Norway spruce; attack other pines and spruce; Landscape and Christmas tree production (young and mature trees)
**Coleoptera**  
*Scolytidae = Curculionidae – Bark Beetles*

- ~50 species in U.S., most attack stressed conifers
- Species vary in spatial distribution of attack within tree
- Bark beetles (cambium feeders / fungus)
- Adults are small (6-8mm) cylindrical, brownish black, antennae are short, elbowed, and clubbed

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**Smaller European Elm Bark Beetle**

- Introduced bark beetle
- Adults – 1/8”; head is bent down; black to reddish brown
- Eggs – laid on trunk or large branches of unhealthy elms
- Larvae – white, legless, “C” shaped
- Host Plants
  - All elms and Japanese Zelkova
  - DED Resistant Elms: “New Harmony”, Valley Forge

---

**Smaller European Elm Bark Beetle**

- Biology
  - 3 to 4 generations / year
  - Larvae overwinter under bark in galleries
  - Adults emerge when 1st elm leaves expand; active several weeks; feed in twig crotches in tree tops of healthy trees; transmit Dutch Elm Disease fungus
  - Adults oviposit in trunk or large branches of unhealthy trees
  - Larvae feed under bark – feeding galleries parallel to wood grain
Smaller European Elm Bark Beetle

- **Management**
  - Cultural - resistant cultivars; don’t plant elms
  - Physical - sanitation by removing flagged branches (best method); remove dying trees; routine pruning only in dormant season
  - Chemical
    - DED - trunk injection with fungicide
    - SEEBB - residual insecticide to tree tops when 1st generation adults start flying

Japanese Cedar Longhorned Beetle *Callidiellum rufipenne*

- 1927 Vancouver, BC
- 1954 Seattle, WA
- 1997 at Manteo, NC
- 2011 – MD, Found on Cryptomeria japonica 'Yoshino' planted in the Severn area of Anne Arundel County
Hosts - taxodium and cypress families

Hosts in its native geographic range:
Japanese cedar (Cryptomeria japonica),
Hinoki cypress (Chamaecyparis obtusa), Sawara cypress (Chamaecyparis pisifera), and false arborvitae (Thujaops Dolabrata).

Hosts in its introduced range: eastern redcedar (US), American arborvitae (US), juniper (Juniperus communis L.) (Italy), and Monterey cypress (Cupressus macrocarpa Hartw.) (Spain).

Firs (Abies spp.) and pine (Pinus spp.) listed as hosts in Asia.

Laurel wilt - disease of redbay (Persea borbonia), avocado (Persea americana), and other trees in the laurel family (Lauraceae).
Causal agent - fungus (Raffaelea sp.)
Vector - a non-native insect, the redbay ambrosia beetle (Xyleborus glabratus)

History in US
- first detected in the United States 2002
- has caused high levels of redbay tree death in Florida, Georgia, and South Carolina, now attacking several other hosts including avocado in residential and experimental settings

Pine Bark Beetle (Ips species)
- ~25 species in North America
- Adults - < ¼”; head bent downward; wing covers have posterior spines
- Larvae - “C” shaped, white, legless
- Host Plants - Most pines and spruces, esp. stressed trees; attack mainly branches and upper trunk (some spp. lower trunk)
**Pine Bark Beetle**  
* (Ips species)  

**Biology**  
- 3 to 4 generations / year  
- Larvae overwinter in galleries  
- Polygamous – male builds mating chamber under bark; 2-7 females attracted and mate; each make their own egg gallery  

**Damage**  
- Beetles boring into healthy trees cause sticky white pitch tubes, whereas stressed trees produce brown boring dust; aggregation pheromone  
- Larvae girdle trees; disrupt nutrient flow  

---  

**Pine Bark Beetle**  
* (Ips species)  

**Biology (con't)**  
- Female lays eggs in notches along side of gallery; eggs hatch; larvae eat through phloem tissue at a right angle to egg gallery; pupate at end of mines; adults bore round holes through bark and emerge > shotholes  

**Damage (con’t)**  
- Blue stain fungus introduced by adults; spread by larvae; fungus spreads inward and clogs water transport vessels; suppress pitch flow  
- Fungus and boring result in tree tops turning yellowish red, dieback
Pine Bark Beetle (Ips species)

• Management
  - Cultural – maintain tree health
  - Physical – remove and destroy heavily infested trees
  - Chemical – monitor for adult activity and treat trunk and branches with residual insecticide; pheromone – mating / aggregation disruptants

Southern Pine Beetle (Dendroctonus species)

• Native bark beetle
• Adults – 1/8”; reddish brown to black; median vertical groove in front of head
• Larvae – “C” shaped, white, legless
• Host Plants – Prefers shortleaf, loblolly, Virginia, and pitch pines; attacks other pines, Norway spruce; attack lower portion of trunk

Southern Pine Beetle (Dendroctonus species)

• Biology
  - 2 to 3 generations / year
  - Larvae overwinter in galleries under bark of dying trees
  - Monogamous – female colonize first, construct egg laying chamber, males come and mate

Southern Pine Beetle (Dendroctonus species)

• Management
  – Cultural – maintain tree health
  – Physical – remove and destroy heavily infested trees
  – Chemical – monitor for adult activity and treat trunk and branches with residual insecticide; pheromone – mating / aggregation disruptants

Fig. 8. Pitch tubes of southern pine beetles
Granulate Ambrosia Beetle and Black Twig Beetle

Granulate Ambrosia Beetle
Xylosandrus crassiusculus (Mot.), Coleoptera

Credits to: Christine Casey, Stephen Bambara, Russ Mizell, John D. Hopkins, James A. Robbins, Michael Davis, Roland Dute, Steve Passoa, Will Hudson

History of Asian Ambrosia Beetle in the US

1974 - First detected in the U.S. in peach trees at Charleston, South Carolina

Now widespread - found in most southeastern, Gulf coast, and surrounding states Texas through Oklahoma

It is found in Oregon, Pennsylvania, Virginia and Maryland.

Fig. 2. Black turpentine beetle pitch tubes
**Life History**

1. Female beetles bore into the sapwood of stems and young trees.
2. These insects make galleries directly into the heartwood of the tree, which they inoculate with a fungus used as their food.
3. The ambrosia fungus that they use as food can block xylem vessels.
4. In addition they can introduce or create entry points for pathogenic fungi such as *Fusarium* spp. Infected nursery trees often die, while landscape plants often seem to recover.

Christine Casey & Stephen Bambara

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**Fungi and larval galleries**

**Management – use good IPM and PHC practices**

- Plant Health Care – an ounce of prevention
- Stressed, damaged, and recently transplanted trees may be more at risk
- Plant correctly – not too deep
- Irrigate in times of drought
- Reject stock with damaged boles or roots
- Plant it in the right place – shade lovers in shade, sun lovers in sun

---

Stressed (drought or flooding), transplanted, freshly cut hosts, and even apparently healthy trees

Seemingly healthy, thin-barked hardwoods or branches from 1.0 to 2.5 inches in diameter.

Host material can range from approximately 0.8 inch to 11.8 inches in diameter.

Casey and Bambara

- Schedl (1962) listed 124 hosts, mostly tropical, in 46 families including coffee, cacao, mango, papaya, Australian pine, rubber, camphor, mahogany, tea, and teak.

- Hosts noted in North America include pecan, peach, plum, cherry, persimmon, oak, elm, sweet gum, magnolia, fig, buckeye, Bradford pear, yellow wood, crape myrtle, red maple, redbud, styrax, ornamental cherry, Japanese maple, golden rain tree, dogwood, sweet gum, Shumard oak, Chinese elm, magnolia, and azalea.
Management – use good IPM and PHC practices

Monitor
- Use visual inspections to determine if trees are infested
- Use alcohol baited traps to monitor flight

Trees may be heavily infested > 50 beetles and may have multiple species of borers including *Xylosandrus*

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Thousand canker disease
- 1928 First described New Mexico in Arizona walnut (*Juglans major*)
- 1992 it was reported from Arizona, New Mexico, and northern Mexico (Chihuahua)
- In 1959 California reports from walnut collected in Los Angeles County
- Native host would be *Juglans californica* (southern California walnut).
- Originated from an introduction that occurred at least a decade earlier.

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Black walnut (*Juglans nigra*) - major disease
Arizona walnut (*Juglans major*) - resistant
Little walnut (*Juglans microcarpa*) - disease not known
Northern California walnut (*Juglans hindsii*) and southern and California walnut (*Juglans californica*) - degrees of intermediate susceptibility
Butternut (*J. cinerea*) - unknown
Persian (English) walnut (*Juglans regia*) - fairly high resistance
Thousand canker disease

*Pityophthorus juglandis*

- *Geosmithia morbida*

“Once a tree is infested, there are no chemical controls that will save it. A tree may be infested by a single beetle or by hundreds. For juvenile trees, one-to three-years old, the infestation most often proves fatal. Mature trees are more often likely to survive the infestation but may serve as staging base for the beetle to attack nearby younger trees.”

Dr. James Robinson - Texas Cooperative Extension

Polyphagous shot hole borer, Kuroshio Shot Hole Borer (Euwallacea spp) and Fusarium dieback

Fusarium infects 260 species of trees. Some of the more susceptible reproductive hosts appear to be box elder, avocado, coral, white alder, castor bean, valley oak, Englemann oak, and several species of sycamore, cottonwood, and willow.

PSHB - from South East Asia, possibly Vietnam. Symbiotic fungus - a new unnamed species, in the genus *Fusarium*

2003 - PSHB was first found at Whittier Narrows in Los Angeles County
2010 - death of box elder street trees in Long Beach
2012 - beetle was collected from a backyard avocado tree in South Gate, and from several tree species at local botanical gardens.
2013 - established in Los Angeles, Orange, and Riverside Counties, and is expanding its range in San Diego County.
2014 - A single beetle was caught in Santa Cruz County.

How far will it spread?

UC Riverside – Center for Invasive Species Research

UC RIVERSIDE Polyphagous shot hole borer / Fusarium Dieback distribution map (February 2016)
How far will it spread?

1. Box elder (Acer negundo)
2. Big leaf maple (Acer macrophyllum)
3. Evergreen maple (Acer paxii)
4. Trident maple (Acer buergerianum)
5. Japanese maple (Acer palmatum)
6. Caster bean (Ricinus communis)
7. California sycamore (Platanus racemosa)
8. Red willow (Salix laevigata)
9. Avocado (Persea americana)
10. Mimosa/silk tree (Albizia julibrissin)
11. English oak (Quercus robur)
12. Coast live oak (Quercus agrifolia)
13. London plane (Platanus x acerifolia)
14. Fremont cottonwood (Populus fremontii)
15. Black cottonwood (Populus trichocarpa)
16. White alder (Alnus rhombifolia)
17. Titoki (Alectryon excelsus)
18. Engelmann oak (Quercus engelmannii)
19. Cork oak (Quercus suber)
20. Valley oak (Quercus lobata)
21. Coral tree (Erythrina corallodendron)
22. Blue pala verde (Cercidium floridum)
23. Pala verde (Parkinsonia aculeata)
24. Moreton Bay chestnut (Castanopsis australis)
25. Brea (Cercidium sonoranum)
26. Mesquite (Prosopis articulata)
27. Weeping willow (Salix babylonica)
28. Chinese holly (Ilex cornuta)
29. Camellia (Camellia sasanqua)
30. Acacia (Acacia spp.)
31. Liquidambar (Liquidambar styraciflua)
32. Red flowering gum (Eucalyptus ficifolia)
33. Japanese wisteria (Wisteria floribunda)

Ranked by observed capacity to produce beetles. Updated list at eskalenlab.ucr.edu.

Invasive shot hole borer management

- Id pest – staining, gunning, frass, sugary exudate
- Look for tiny holes ~ 0.9 mm
- If only branches infested, prune out and treat cuts.
- Treat and monitor tree
- If trunk is also infested and it is a reproductive host, remove tree
- Chip wood to less than 1” or solar compost
- Arborjet recommends treatment with emamectin benzoate + propizol

Reproductive hosts

- Clearwing moths / borers Sesiidae

Banded Ash Clearwing Sesiidae

- Insect
  - Adults ¾”, yellow banded legs, metallic brownish black front wings and abdomen, males have 1 yellow band on abdomen
- Host Plants
  - feed only on ash species

Banded Ash Clearwing Sesiidae

- Biology
  - 1 generation, overwinter as larvae in galleries in wood
  - Adults emerge in Sept.; mate and lay eggs on bark
  - Eggs hatch and larvae bore into wood; overwinter; feed throughout summer
**Banded Ash Clearwing**

*Sesiidae*

- **Damage**
  - larvae feed on wood under bark
  - heavy infestations result in branch dieback and tree death
  - bark cracking
  - frass / sawdust and holes will be present on bark

- **Monitoring**
  - visual for active larvae in summer (frass and irregular holes); for brown pupal skins projecting from holes in Sept.; use pheromone trap to time adult activity

- **Management**
  - Biological – *Steinernema carpocapsae* nematodes to target larvae May – July
  - Chemical – protect bark from larvae with insecticide 10 days after 1st moth is trapped – Acelepryn works well

**Lilac / Ash Borer**

*Sesiidae*

- **Insect**
  - Adults ~1”, wasp mimic, dark metallic brown with no yellow bands

- **Host Plants**
  - Attack lilac, ash, and privet

- **Biology**
  - 1 generation, overwinter as larvae in galleries in wood
  - Adults emerge in April / June; mate and lay eggs on bark
  - eggs hatch and larvae bore into wood; overwinter; feed throughout summer

**Dogwood Borer**

*Sesiidae*

- **Insect**
  - Adults ~3/8”, dark metallic brown, males with 2 narrow yellow bands on abdomen

- **Host Plants**
  - Prefers dogwood, especially wounded trees
Dogwood Borer
Sesiidae

- Management
  - Resistant plant – Kousa dogwood
  - Mechanical – prune out dead
  - Biological – *Steinernema carpocapsae* nematodes to target larvae mid to late summer
  - Chemical – protect bark from larvae with insecticide 10 days after 1st moth is trapped
**Rhododendron Borer**

*Sesiidae*

- **Insect**
  - Adults ~1/2", blue black, males with 3 narrow yellow bands on abdomen

- **Host Plants**
  - Prefers Rhododendron, azalea, mountain laurel

- **Damage**
  - Larvae bore into branches, flagging, dieback

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**Peachtree Borer**

*Sesiidae*

- **Insect**
  - Adults ~1/2", blue black, males are mostly black, females 1 wide yellow band

- **Host Plants**
  - Prefers flowering cherry, peach, other *Prunus* spp.

- **Damage**
  - Larvae bore under bark in trunk at or below ground level; heavy mulching or wounding
Lesser Peachtree Borer
Sesiidae

- Insect
  - Adults ~3/4”, blue black, males are mostly black, females 1 wide yellow band; 2 generations
- Host Plants
  - Prefers flowering cherry, peach, cherry laurel, other Prunus spp.
- Damage
  - Larvae bore under bark in trunk, in tree crotches, sometimes on trunk wounds; sometimes gummosis present

Nantucket Pine Tip Moth
Tortricidae

- Insect
  - Adults ~1/4”, wings silvery grey with rust; Larvae 3/8”, tan with brown head
- Host Plants
  - Feeds on most pines, prefers mugho, loblolly, pitch, Virginia, Scotch, Japanese black