

Biology and management of the goldspotted oak borer and polyphagous shot hole borer

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Goldspotted oak borer (GSOB)
(*Agrilus auroguttatus*)



Background



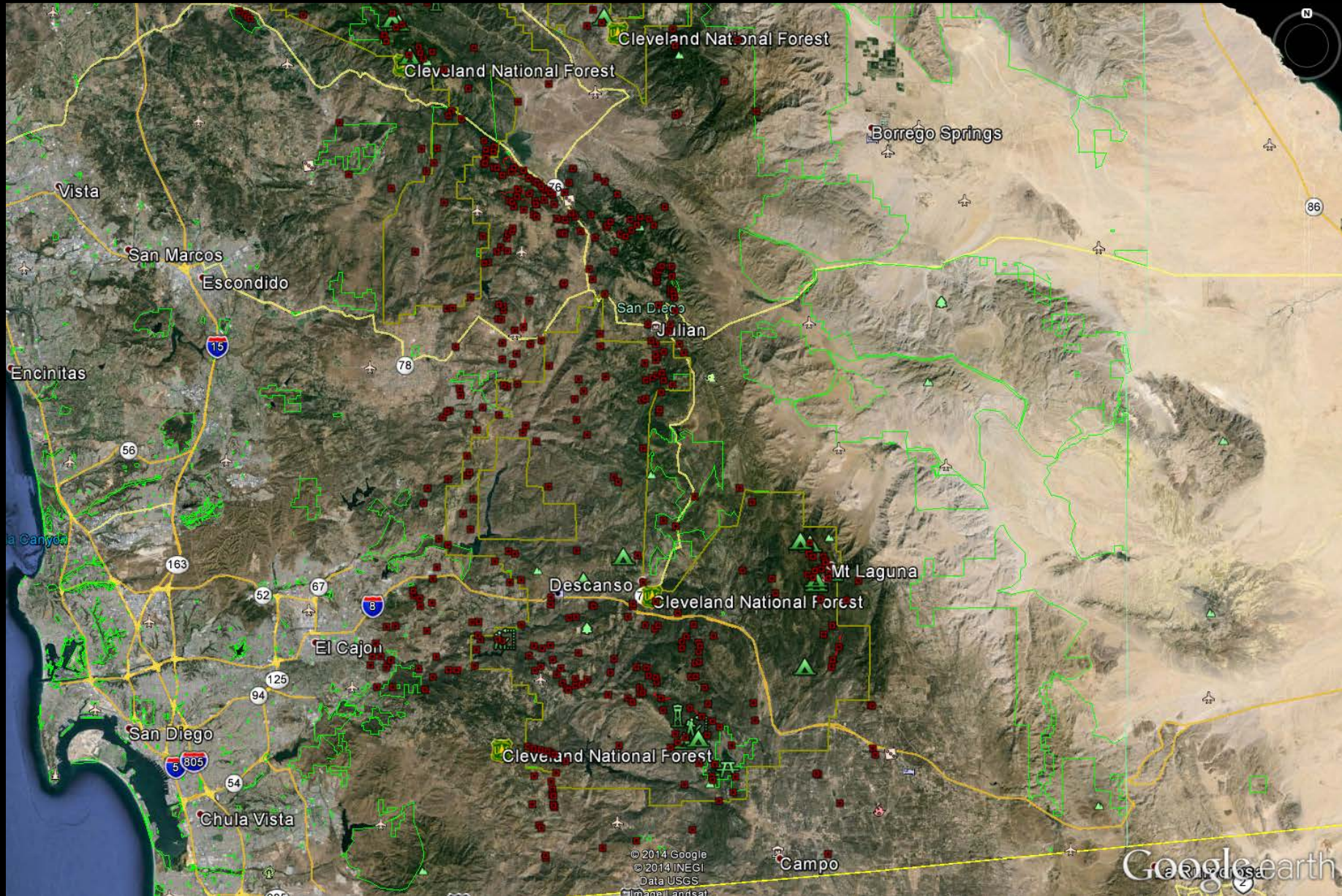
- GSOB was likely introduced to California from Arizona
- GSOB favors large diameter red oaks
 - Coast live oak
 - California black oak
- GSOB completes one generation a year, adults fly from May to September and larvae feed from July to November

GSOB larval feeding



- Larval feeding girdles a tree's cambium
- Several years of repeated larval feeding are required to kill a tree

2014 mapped oak mortality



GSOB integrated pest management

Table 1. Approximate timing of the goldspotted oak borer, *Agrilus auroguttatus*, life cycle in southern California (A) and optimal timing of trapping period (B); application of contact (C) and systemic insecticides (D); and timing of mechanical grinding and tarping of infested oak wood for the goldspotted oak borer (E).

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---------------------------------|-----------------|--------|------------|---------------------|---|----------------------------------|-----------|---|---|---|
| A | | | | Adults | | | | | | | | |
| | | | | | Egg laying | | | | | | | |
| | | | | | | Larval feeding | | | | | | |
| | | | | | | | | | Pre-pupae | | | |
| | | | Pupae | | | | | | | | | |
| B | | | Trapping period | | | | | | | | | |
| C | | Contact insecticide application | | | | | | | | | | |
| D | | | | | | | | Systemic insecticide application | | | | |
| E | | | | | | Mechanical grinding | | | | | | |
| F | | | Tarping period | | | | | | | | | |

- Forest Insect and Disease Leaflet
 - Coming out late 2014 or early 2015

GSOB integrated pest management



- Developing an IPM program for high-value sites
 - Include monitoring, tree removal, and specific plans for preventative treatments

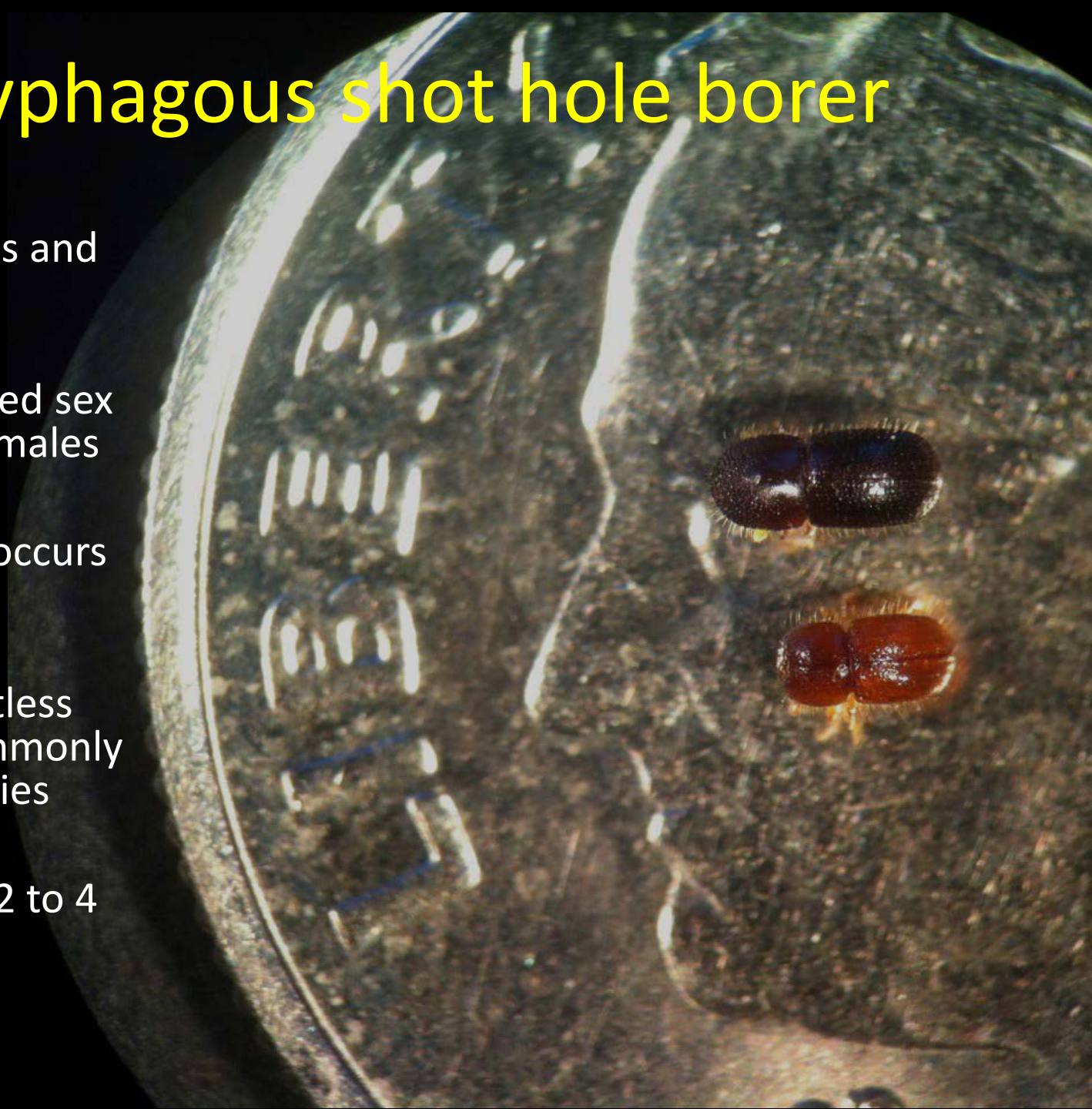
Polyphagous shot hole borer (PSHB), *Euwallacea* sp.



- First detected in California in 2003
 - Insect/disease complex not linked to tree injury and mortality until 2012 in LA County
- PSHB was initially believed to be the tea shot hole borer, *Euwallacea fornicatus*
 - Recent DNA work suggests PSHB may be a new species and this same species is found in Israel
 - Our PSHB population may be from Vietnam/ S. China

Polyphagous shot hole borer

- Feeds on fungus and not the wood
- There is a skewed sex ratio toward females
- Sibling mating occurs in the galleries
- Males are flightless and do not commonly leave the galleries
- May complete 2 to 4 generations/yr



Insect/Disease complex: PSHB and Fusarium dieback



- PSHB carries several fungi
 - *Fusarium euwallaceae* (new species)
 - *Graphium* sp.
 - *Sarocladium* sp.
 - Eskalen (UCR) is conducting pathogenicity tests with each fungus

PSHB known host species

Table 1. Known reproductive hosts, agricultural crop hosts and native species hosts of the polyphagous shot hole borer/fusarium dieback disease complex as of February 2014^a.

| | Reproductive Hosts | Agricultural Crop Hosts | Native Species Hosts |
|-----|---|--|---|
| 1. | Box elder (<i>Acer negundo</i>) | Avocado (<i>Persea americana</i>) | California box elder (<i>Acer negundo</i> var. <i>californicum</i>) |
| 2. | Castor bean (<i>Ricinus communis</i>) | Japanese persimmon (<i>Diospyros kaki</i>) | Coast live oak (<i>Quercus agrifolia</i>) |
| 3. | Avocado (<i>Persea americana</i>) | Olive (<i>Olea europaea</i>) | California sycamore (<i>Platanus racemosa</i>) |
| 4. | English oak (<i>Quercus robur</i>) | Macadamia (<i>Macadamia integrifolia</i>) | Big leaf maple (<i>Acer macrophyllum</i>) |
| 5. | Coast live oak (<i>Q. agrifolia</i>) | Mulberry (<i>Morus</i> spp.) | Red willow (<i>Salix laevigata</i>) |
| 6. | California sycamore (<i>Platanus racemosa</i>) | Hazelnut (<i>Corylus colurna</i>) | Valley oak (<i>Q. lobata</i>) |
| 7. | Big leaf maple (<i>A. macrophyllum</i>) | Loquat (<i>Eriobotrya japonica</i>) | Blue palo verde (<i>Parkinsonia florida</i>) |
| 8. | Mimosa (<i>Albizia julibrissin</i>) | Peach (<i>Prunus persica</i>) | Engelmann oak (<i>Q. engelmannii</i>) |
| 9. | Coral tree (<i>Erythrina corallodendron</i>) | Grape (<i>Vitis vinifera</i>) | White alder (<i>Alnus rhombifolia</i>) |
| 10. | Titoki (<i>Alectryon excelsus</i>) | Sweet orange (<i>Citrus sinensis</i>) | Canyon live oak (<i>Q. chrysolepis</i>) |
| 11. | Blue palo verde (<i>Parkinsonia florida</i>) | Cassava (<i>Manihot esculenta</i>) | California bay laurel (<i>Umbellularia californica</i>) |
| 12. | Tortuosa (<i>Salix matsudana</i>) | | Desert fan palm (<i>Washingtonia filifera</i>) |
| 13. | Weeping willow (<i>S. babylonica</i>) | | California buckeye (<i>Aesculus californica</i>) |
| 14. | Red willow (<i>S. laevigata</i>) | | Velvet ash (<i>Fraxinus velutina</i>) |
| 15. | Trident maple (<i>A. buergerianum</i>) | | Coffee berry (<i>Rhamnus californica</i>) |
| 16. | Japanese maple (<i>A. palmatum</i>) | | |
| 17. | Evergreen maple (<i>A. paxii</i>) | | |
| 18. | Chinese holly (<i>Ilex cornuta</i>) | | |
| 19. | Brea (<i>Cercidium sonora</i>) | | |
| 20. | Black bean (<i>Castanospermum australe</i>) | | |
| 21. | Camellia (<i>Camellia semiserrata</i>) | | |
| 22. | Cork oak (<i>Q. suber</i>) | | |
| 23. | Red flowering gum (<i>Eucalyptus ficifolia</i>) | | |
| 24. | Engelmann oak (<i>Q. engelmannii</i>) | | |
| 25. | Palo verde (<i>P. aculeata</i>) | | |
| 26. | Sweetgum (<i>Liquidambar styraciflua</i>) | | |

^aFor a complete list of all host species see: Eskalen et al. 2013. Plant Disease 97(7):938-951.

PSHB injury symptoms



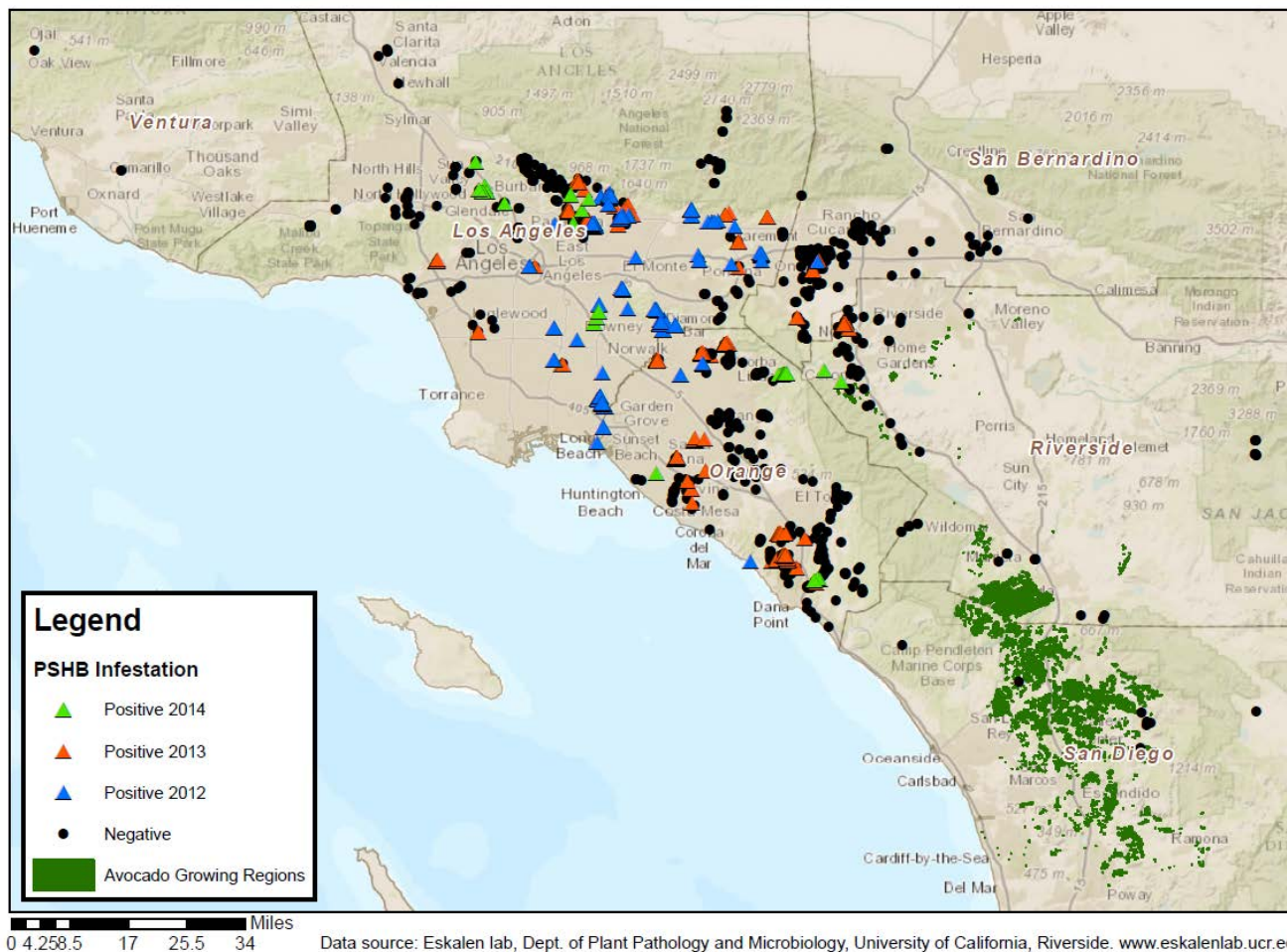


- PSHB larval galleries



- Box elder killed by PSHB

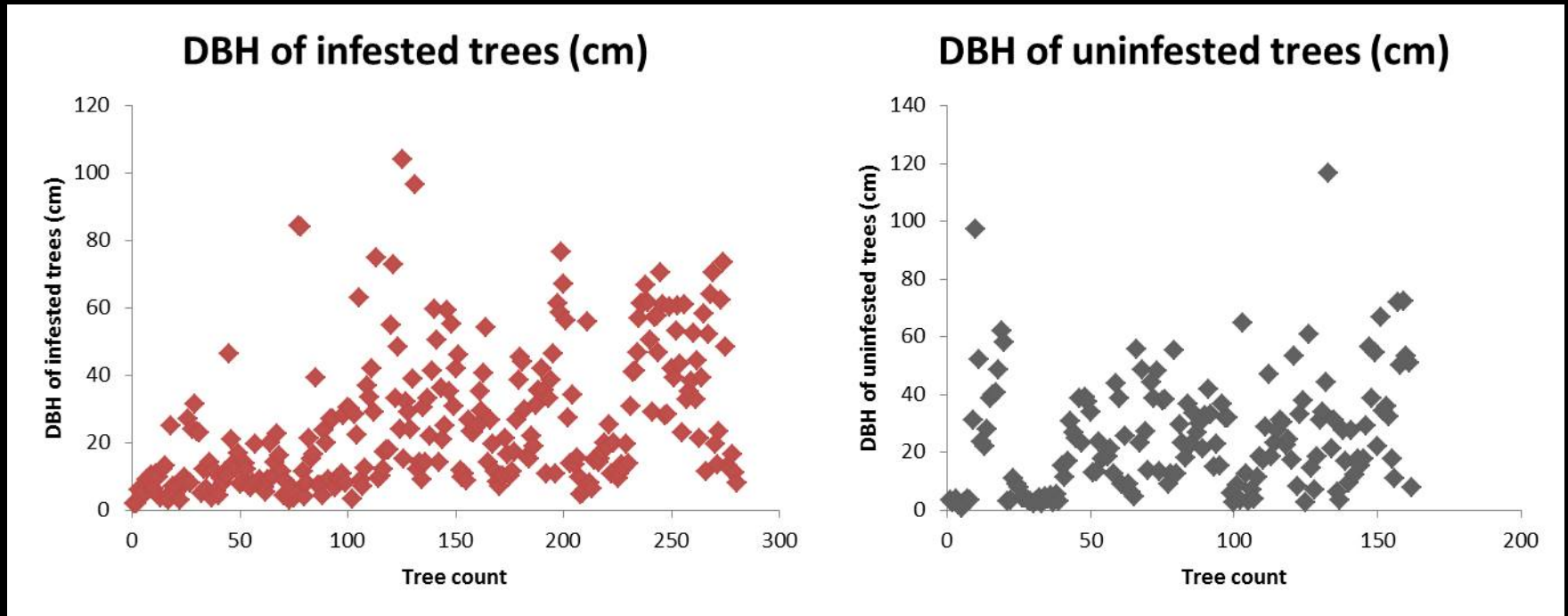
Current distribution of PSHB in CA



- Infested counties:
 - Los Angeles
 - Orange
 - Riverside
 - San Bernardino
 - San Diego

- El Cajon (San Diego Co.): Recent detection of PSHB
 - Population may be from Taiwan

Preliminary survey data:



- PSHB attacks all size classes
 - DBH range of infested trees: <1 to 40.9 inches
- Attacks are more common along the main stem

Preliminary survey data:

- ~800 trees surveyed across four sites

| Species | % infested (% severely injured) (% dead with PSHB) |
|---------------------|--|
| Box elder | 89% (83%) (30%) |
| Red willow | 83% (49%) (17%) |
| Castor bean | 68% (71%) (16%) |
| Willow sp. | 88% (0%) (7%) |
| California sycamore | 77% (25%) (5%) |
| Fremont cottonwood | 60% (61%) (4%) |
| White alder | 74% (18%) (2%) |
| Ash spp. | 32% (8%) (0%) |
| Coast live oak | 23% (0%) (0%) |
| California walnut | 23% (0%) (0%) |

PSHB management

- Management options for PSHB are similar to GSOB:
 - Tree removal
 - Tarping/solarization
 - Chipping
 - Insecticide options
 - Systemic and contact
 - Fungicide options
 - Biological control
 - For fungi and insects



Polyphagous Shot Hole Borer + Fusarium Dieback Decision Making for Reproductive Hosts

WHAT IS A REPRODUCTIVE HOST?

A reproductive host is a tree species that is suitable for successful beetle reproduction, production of the next generation of beetles, and the growth and development of the symbiotic fungi. At present, these reproductive hosts are the priority species for any kind of control because they are able to produce more beetles.

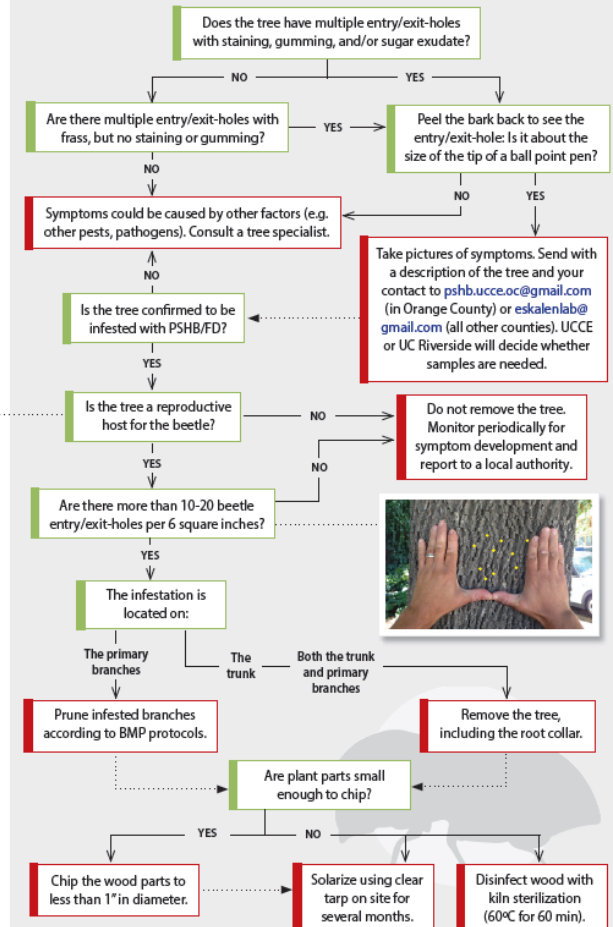
CURRENT REPRODUCTIVE HOST LIST

1. Box elder (*Acer negundo*)
2. Big leaf maple (*Acer macrophyllum*)
3. Evergreen maple (*Acer pauciflorum*)
4. Trident maple (*Acer buergerianum*)
5. Japanese maple (*Acer palmatum*)
6. Castor 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. Cottonwood (*Populus fremontii*)
15. White alder (*Alnus rhombifolia*)
16. Titoki (*Alectryon excelsus*)
17. Engelmann oak (*Quercus engelmannii*)
18. Cork oak (*Quercus suber*)
19. Valley oak (*Quercus lobata*)
20. Coral tree (*Erythrina corallodendron*)
21. Blue palo verde (*Cercidium floridum*)
22. Palo verde (*Parkinsonia aculeata*)
23. Moreton Bay chestnut (*Castanospermum australe*)
24. Brea (*Cercidium sonora*)
25. Mesquite (*Prosopis articulata*)
26. Weeping willow (*Salix babylonica*)
27. Chinese holly (*Ilex cornuta*)
28. Camellia (*Camellia semiserrata*)
29. Acacia (*Acacia* spp.)
30. Liquidambar (*Liquidambar styraciflua*)
31. Red flowering gum (*Eucalyptus ficifolia*)

CONTACT

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WHAT YOU CAN DO FOR REPRODUCTIVE HOST TREES

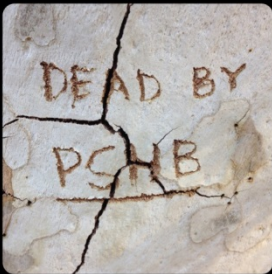


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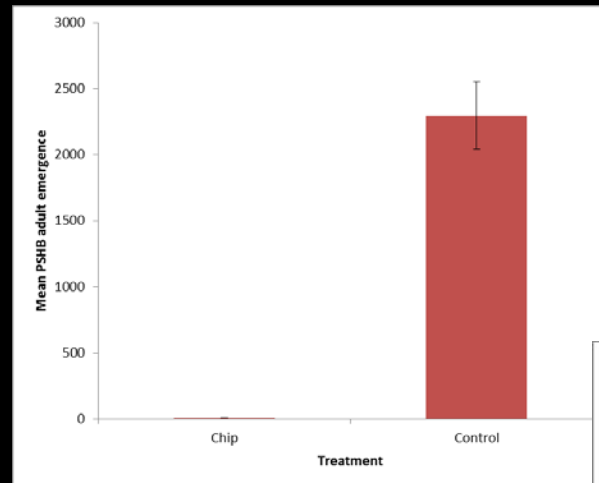
Management options in development for an IPM program

- Monitoring/Surveys
 - Need an effective lure
 - Ground surveys are currently the best survey tool
- Management
 - Prophylactic treatments – protect trees before they are infested
 - Remedial treatments – interfere with beetle and fungi after infestation
 - Long term solutions – biological control
- Work being conducted by FHP, UCR, private companies, APHIS, ARS, counties, etc.

Management options

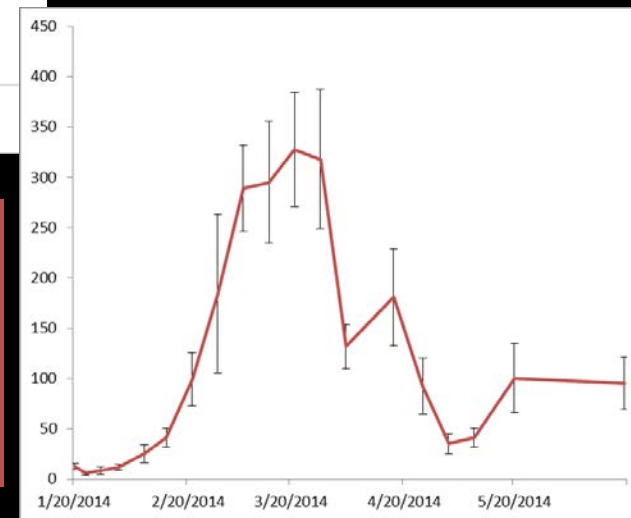


- Sycamore, red willow, and coast live oak
 - Chipped into ~1 inch pieces
- Total adult PSHB emergence:
 - Chips: 56
 - Control logs: 16,085



- Chipping wood was >99% effective at killing PSHB

- Beetles emerged from wood ~4 mo after tree was cut



Management options

- Insecticide work is being conducted primarily by Tim Paine's lab (UCR)
- Insecticide options
 - Imidacloprid
 - Dinotefuran
 - Bifenthrin
 - Clothianidin- not effective in initial trials
- Unknowns:
 - If these treatments can save infested trees
 - Retreatment times
 - Insecticide and fungicide applications



Reduced PSHB attacks in initial trials

PSHB integrated pest management



- Developing an IPM program for high-value sites
 - Include monitoring, tree removal, chipping, specific plans for preventative treatments (tree species to treat), education/outreach

Questions

- More information
 - GSOB: www.gsob.org
 - PSHB: www.ucr.cisr.edu

