



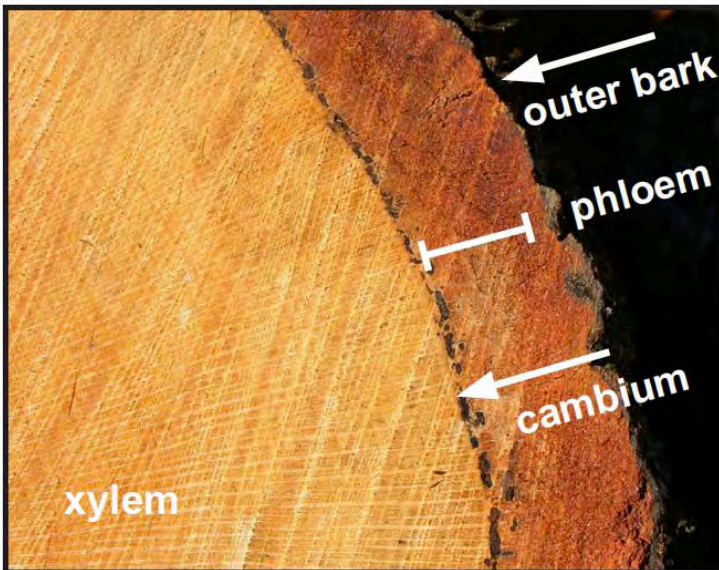
Goldspotted Oak and Shot Hole Borers: *Devastating Threats to California Trees*



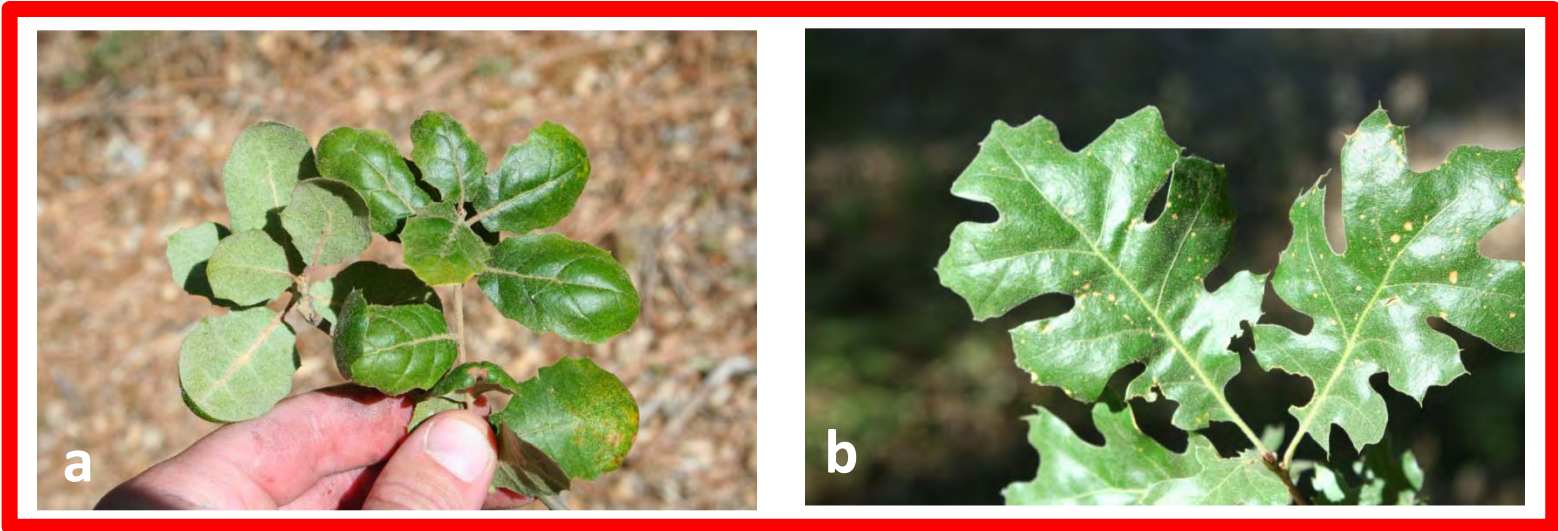
Prepared by: Jan Gonzales
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Goldspotted Oak Borer (GSOB)

(Agrilus auroguttatus)



GSOB hosts in California



(a) Coast live oak, *Quercus agrifolia* (b) California black oak, *Q. kelloggii*
(c) Canyon live oak, *Q. chrysolepsis* (d) Englemann oak, *Q. engelmanni*



Los Angeles County



Orange County

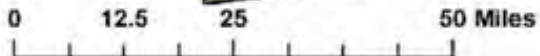


Riverside County

San Diego County

GSOB Locations and Zones of Infestation

-  2015 LA ZOI
-  2015 LA County GSOB Locations
-  2015 Orange County GSOB ZOI
-  2015 Orange County GSOB Locations
-  2014 Riverside ZOI
-  2014 GSOB Riverside Locations
-  2015 San Diego GSOB ZOI
-  2015 San Diego GSOB Locations
-  2014 San Diego GSOB Locations
-  2012 San Diego GSOB Locations
-  California Counties

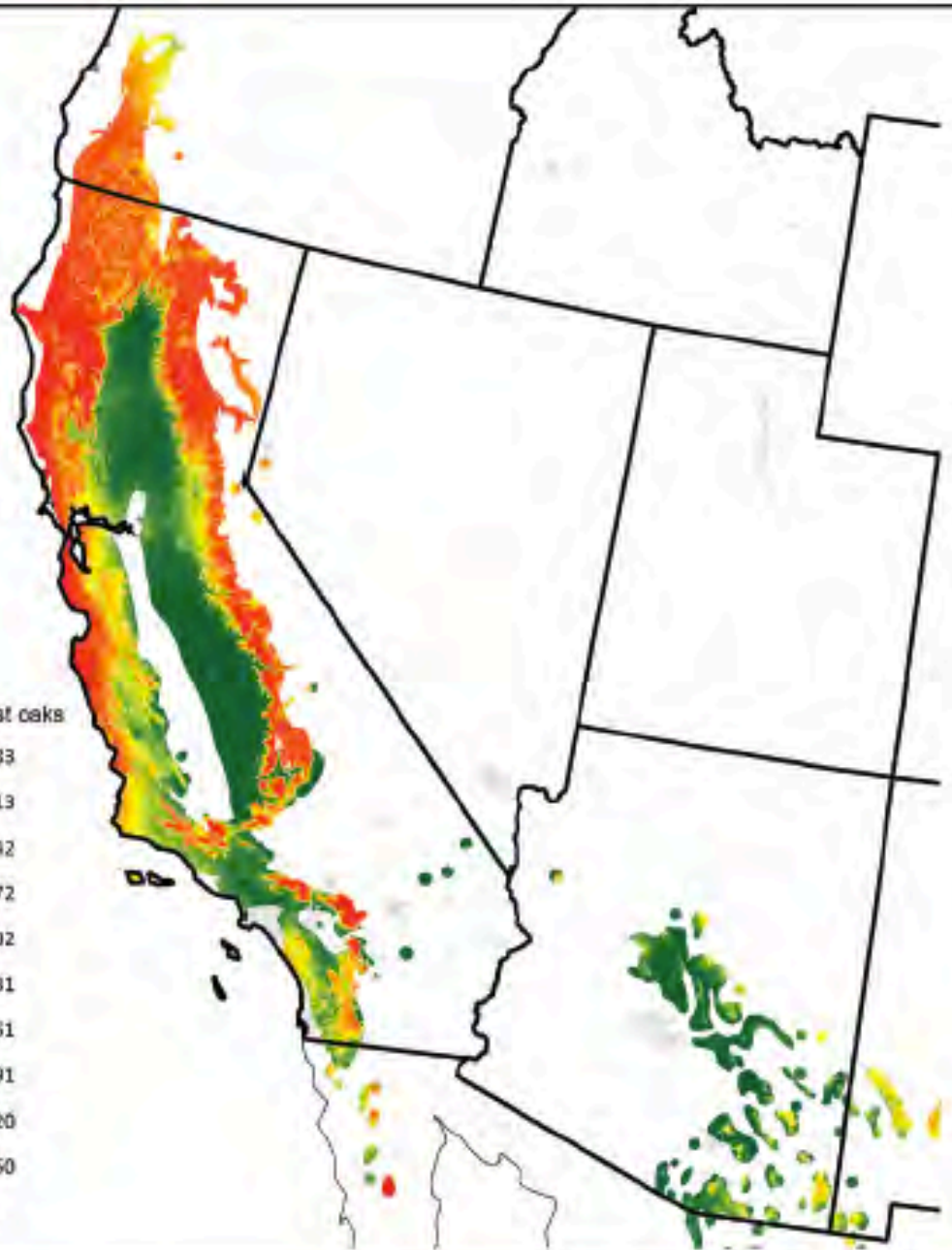


Map | Kim Corella/CAL FIRE



Resources at Risk: Potential Spread of Goldspotted Oak Borer into Suitable Habitat

Climate suitability (D-1000) within distribution of host oaks



GSOB injury across
several size classes



<10" DBH

30% injured by GSOB
6% dead with GSOB injury

10-20" DBH

61% injured by GSOB
8% dead with GSOB injury

20-30" DBH

77% injured by GSOB
26% dead with GSOB injury

>30" DBH

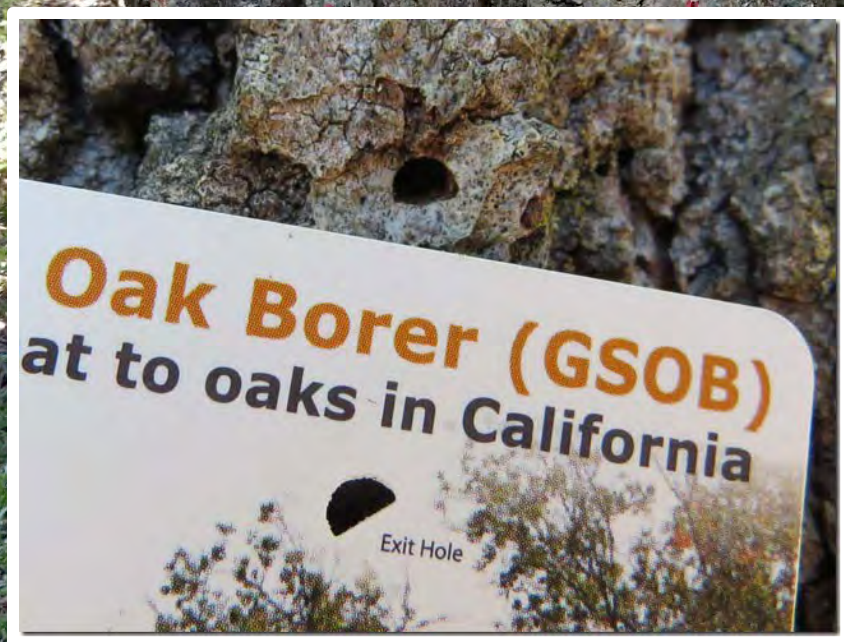
85% injured by GSOB
40% dead with GSOB injury

DBH=tree diameter at breast height

Symptoms/Evidence of Attack



GSOB exit holes

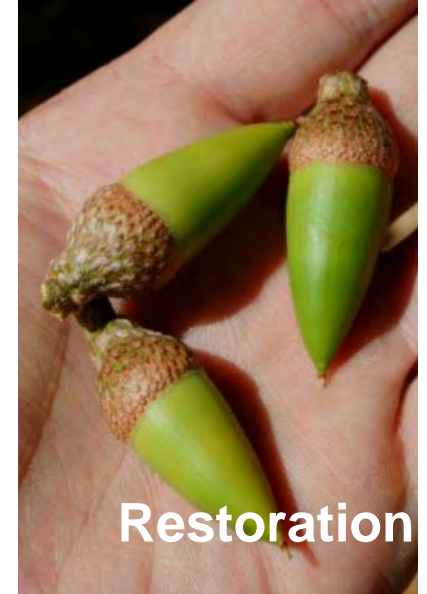


GSOB life cycle and management timing

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

Table 1. Approximate timing of the goldspotted oak borer 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 (E) and tarping (F) of infested oak wood.

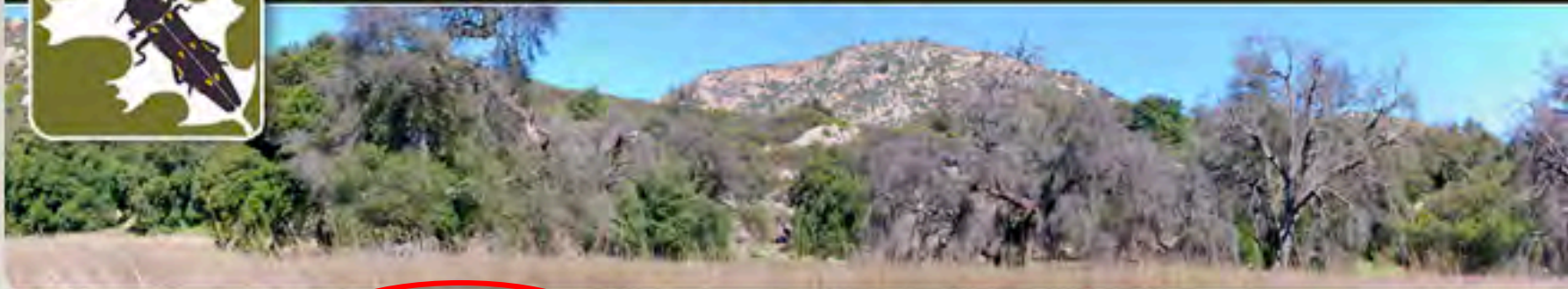
Integrated pest management (IPM)



Restoration



Goldspotted Oak Borer



Home About GSOB **Diagnosis & Management** Recovery What You Can Do News & Events Resources Contacts

Diagnosis

Identification and Symptoms

[Host oak species](#)

[Goldspotted Oak Borer Identification](#)

[Symptoms of goldspotted oak borer attack](#)

Assessment and Diagnosis Resources

- [Goldspotted Oak Borer Pest Note](#) (PDF)
University of California Integrated Pest Management (IPM)
- [GSOB Field Identification Guide](#) (PDF)
University of California Integrated Pest Management (IPM)
- [Southern California Oak Resource Assessment Reference Guide](#) (PDF)

Sampling and Reporting Informa

[Online GSOB Symptoms Report Form](#)

County of San Diego Entomology:

- [Insect Sampling/Trapping and Submittal](#)
- [Insect Sampling and Submittal Form](#) (PD

Infested wood treatment and utilization

The danger posed by infested wood:



This amount of bark produced...



Processing Considerations for GSOB Oaks



- Big, very heavy and dense chunks;
- Thick bark often remains after seasoning;





GSOB Debarking Method



Managing GSOB-infested wood



Beetle and Fungi



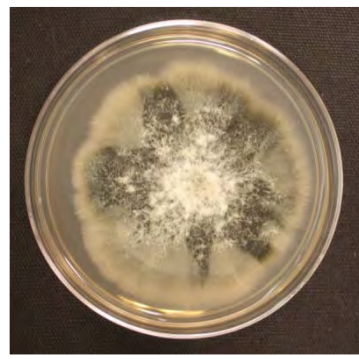
Adult female: 1.8-2.5 mm long



Adult male: 1.5 mm long



Fusarium euwallaceae



Graphium sp.



Acremonium sp.

PSHB Reproductive Hosts

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. **Castor bean** (*Ricinus communis*)
7. **California sycamore** (*Platanus racemosa*)*
8. **Mexican sycamore** (*Platanus mexicana*)
9. **Red willow** (*Salix laevigata*)*
10. **Avocado** (*Persea americana*)
11. **Mimosa/Silk tree** (*Albizia julibrissin*)
12. **English oak** (*Quercus robur*)
13. **Coast live oak** (*Quercus agrifolia*)*
14. **London plane** (*Platanus x acerifolia*)
15. **Fremont cottonwood** (*Populus fremontii*)*
16. **Black cottonwood** (*Populus trichocarpa*)*
17. **White alder** (*Alnus rhombifolia*)*
18. **Titoki** (*Alectryon excelsus*)
19. **Engelmann oak** (*Quercus engelmannii*)*
20. **Cork oak** (*Quercus suber*)
21. **Valley oak** (*Quercus lobata*)*
22. **Coral tree** (*Erythrina corallodendron*)
23. **Blue palo verde** (*Cercidium floridum*)*
24. **Palo verde** (*Parkinsonia aculeata*)
25. **Moreton Bay chestnut** (*Castanospermum australe*)
26. **Brea** (*Cercidium sonora*)
27. **Mesquite** (*Prosopis articulata*)*
28. **Weeping willow** (*Salix babylonica*)
29. **Chinese holly** (*Ilex cornuta*)
30. **Camellia** (*Camellia semiserrata*)
31. **Acacia** (*Acacia spp.*)
32. **American sweetgum** (*Liquidambar styraciflua*)
33. **Red flowering gum** (*Eucalyptus ficifolia*)
34. **Japanese wisteria** (*Wisteria floribunda*)
35. **Goodding's black willow** (*Salix gooddingii*)*
36. **Tree of heaven** (*Ailanthus altissima*)
37. **Kurrajong** (*Brachychiton populneus*)
38. **Black mission fig** (*Ficus carica*)
39. **Japanese beech** (*Fagus crenata*)
40. **Shiny xylosma** (*Xylosma congestum*)

* Native Species

KSHB Reproductive Hosts

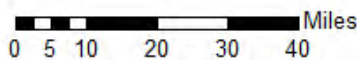
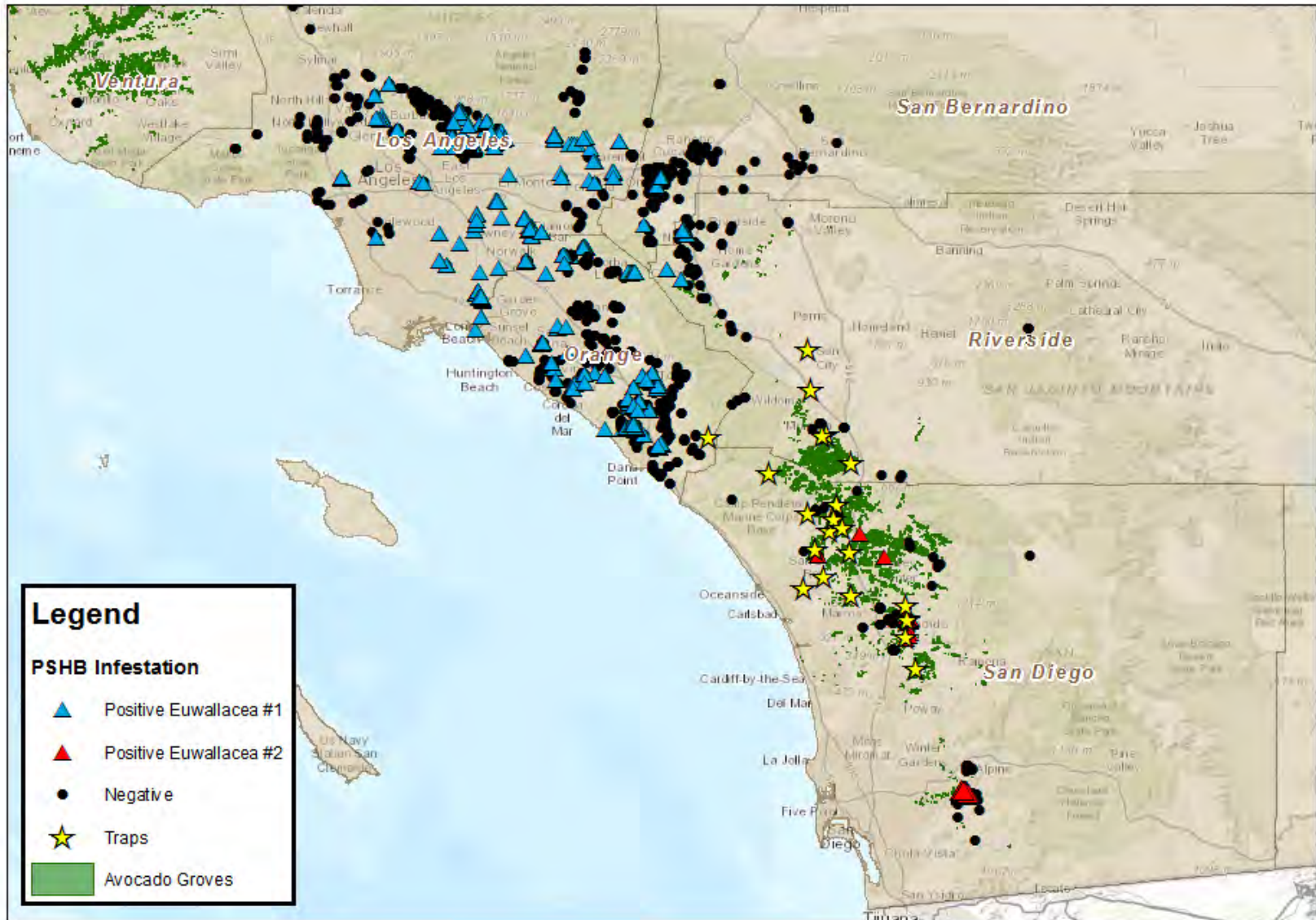


Photo: Monica Dimson/UCCE Orange County

1. Avocado (*Persea americana*)
2. California sycamore (*Platanus racemosa*)*
3. Coast live oak (*Quercus agrifolia*)*
4. Cork oak (*Quercus suber*)
5. Draft coral tree (*Erythrina humeana*)
6. Black poplar (*Populus nigra*)*
7. Black locust (*Robinia pseudoacacia*)
8. Red willow (*Salix laevigata*)*
9. Arroyo willow (*Salix lasolepis*)*
10. Fremont cottonwood (*Populus fremontii*)*
11. Mimosa/Silk tree (*Albizia julibrissin*)
12. Castor bean (*Ricinus communis*)
13. Black Willow (*Salix nigra*)*
14. Strawberry Snowball Tree (*Dombeya cacuminum*)

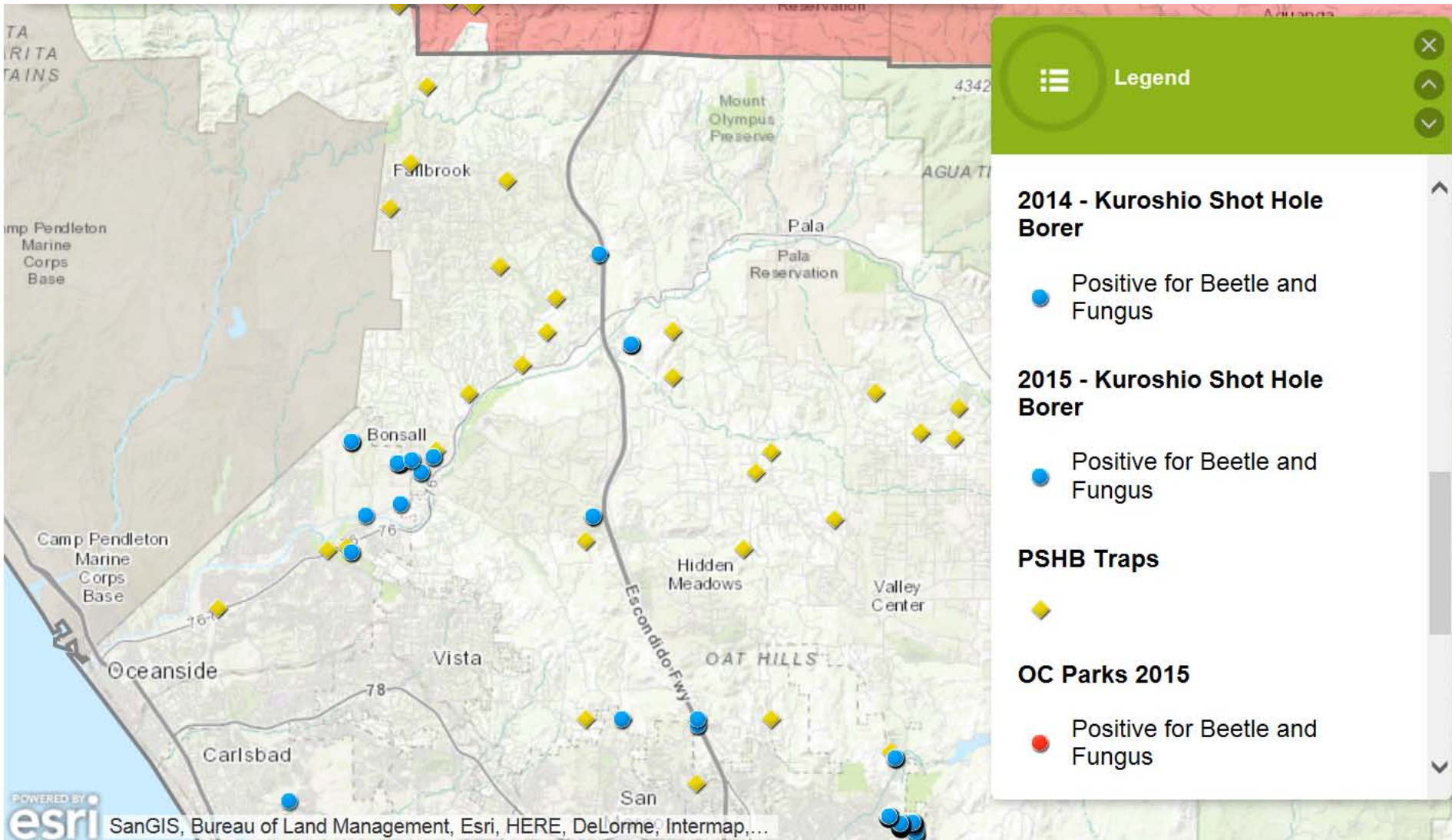
* Native Species

Polyphagous shot hole borer / *Fusarium* Dieback distribution map (December 2014)



KSHB Infestations and Traps in in Fallbrook Area

www.pshb.org 9-12-16





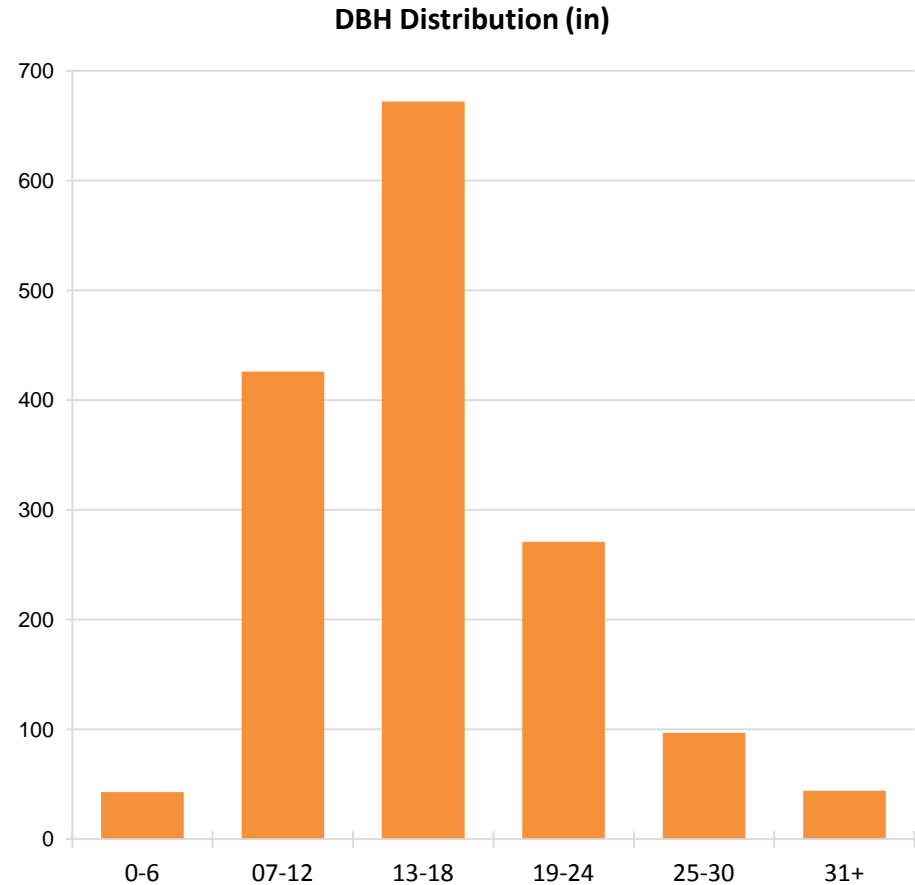
Box elder at the Huntington Botanical Gardens – about 2.5 years after first decline was detected.

1-ft length of **Castor bean** trunk at Tijuana River Valley Regional Park - resulted In 455 beetles over a period of one month.

California sycamore
53.52% of OCP infestation

DBH Class of Infested Trees [All species]

DBH (inches)	Infested Trees	Percent of Total Infestation
0-6	43	3%
07-12	426	27%
13-18	672	43%
19-24	271	17%
25-30	97	6%
31+	44	3%
Total	1553	



Infested Sycamore tree in UCI

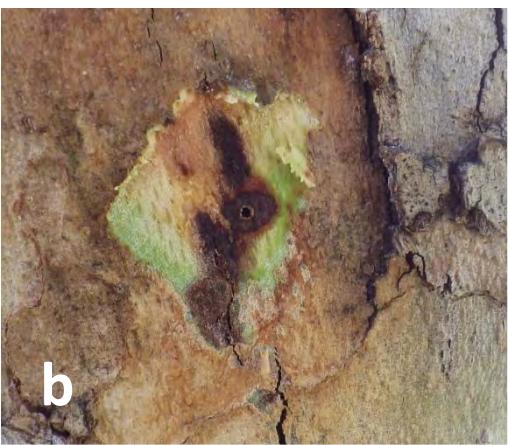
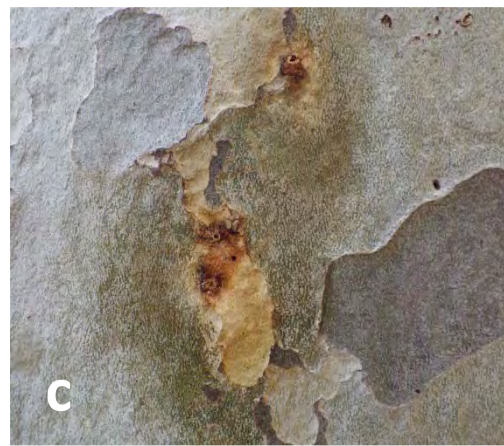
24"
60cm



7"
18cm



Signs and Symptoms



(a) Round entry/exit hole ~ 0.85 mm in diameter (b) staining beneath bark
(c) bark staining (d) gumming (e) frass (f) sugary exudate

ISHB

Integrated Pest Management

- **Monitor**
 - Traps with lure - quercivorol
- **Survey**
 - Host species
 - Infestation level
 - Host value
 - Hazard level
- **Management Decisions**
 - Continue monitoring
 - Tree removal/wood management
 - Treat/Prune infested branches
 - Preventative treatments



ISHB Management: Factors to Consider

- **Host Species**
Is the tree a reproductive host?
- **Infestation Level**
How advanced is the infestation?
- **Host Value**
Is the host of high economic or cultural value?
- **Hazard Level**
Does the infested tree pose a safety risk to people or property?

Definitions for host value and hazard level (and in some cases, infestation level) will vary depending on the infestation site.



Pitfall trap with lure at **Avocado** grove.

Infestation Level

Level of Infestation	# Entry/Exit Holes	Dieback Observed
Low	< 30	No
Moderate	≥ 30	No
Heavy	≥ 30	Yes

Removal recommended for:

- 1) heavily infested trees
- 2) trees at historic/cultural sites



			PSHB Infestation Level					
	Host Species	Hazard Level	No infestation	Low	Moderate	Heavy	Severe	
HIGH VALUE HOSTS	Reproductive	Low	Preventative treatment	Treat/prune infested branches	Treat/prune infested branches	Treat/prune infested branches	Remove tree or infested branches	
		High	Preventative treatment	Treat/prune infested branches	Treat/prune infested branches	Remove tree or infested branches	Remove tree or infested branches	
	Non-Reproductive	Low	Monitor	Monitor	Notify UC ANR; reclassify species as reproductive host in consultation with PSHB/FD experts			
		High	Monitor	Monitor				

			PSHB Infestation Level					
	Host Species	Hazard Level	No infestation	Low	Moderate	Heavy	Severe	
LOW VALUE HOSTS	Reproductive	Low	Monitor	Monitor	Remove tree or infested branches	Remove tree or infested branches	Remove tree or infested branches	
		High	Monitor	Treat/prune infested branches	Remove tree or infested branches	Remove tree or infested branches	Remove tree or infested branches	
	Non-Reproductive	Low	Monitor	Monitor	Notify UC ANR; reclassify species as reproductive host in consultation with PSHB/FD experts			
		High	Monitor	Monitor				

Control Options

Cultural / Sanitation

- Tree and stump removal
- Pruning infested branches
- Pruning wound protection (bifenthrin +)
- Chipping, Composting, Solarization
- Restrict firewood movement

Chemical- Prevention

- Prophylactic Trunk sprays - bifenthrin
- Prophylactic Systemic-Soil injection, drench, trunk injection
- **Beetle and/or Fungal Symbionts?**

Biocontrol? (Long Term Strategy)

- **Natural Enemies?**
- **Use of Entomopathogenic Fungi?**
- **Use of Endophytic bacteria and/or fungi?**

Advanced Use of Monitoring Tools

- **Use of flight data in management decisions?**
- **Lure and Pesticides -Attract & Kill Traps?**

Cultural Control and Sanitation

- Tree removal
- Treatment of slash and debris
- Chipping or grinding
- Solarization and composting
- Firewood movement



Mark Adams, Downey Trees, Bugwood.org

5376264



Joseph O'Brien, USDA Forest Service, Bugwood.org

UGA5039049

Similarities & Differences Affecting Utilization



GSOB

- Red oaks species in wildland and urban settings
- Larger-sized trees
- Readily moved in infested wood
- Infests only bark
- Danger for 1 year +
- Solarization ineffective
- Oak a prized firewood
- Grind to 3" minus standard
- No pathogens concern?
- No need to compost chips
- No Ag component or risk
- Lack of facilities and options

P/KSHB

- Multiple species found in wildland/urban/ag settings
- Small and large sized trees
- Readily moved in infested wood
- Infests bark & wood
- Beetle-free ≤ 6 months?
- Solarization effective
- Less firewood value
- Grind to 1" minus
- Must consider pathogens
- Composting recommended?
- Ag component and risk
- Lack of facilities and options

P/KSHB-infested firewood:

Many of the susceptible tree species have far lesser value as firewood when compared to oak. SHB can also infest smaller diameter material vs. only larger diameter oaks with GSOB.



Infested wood sources

- Federal, state and local forests/parks/reserves
- Private woodlands
- Organizational camps
- Small landowners
- Street trees
- Utilities & road departments
- Tree Services
- Orchard replacement or sanitation



Containment



Curing/seasoning



Kiln



Air Curtain Burner



Commercial Capacity and Interest

- Sawmills – Small scale and very limited interest
- Biomass Power – Opportunities fading?
- Gasification
- Mulch and Soil Amendments
Adequate capacity?
- Specialty products (mushrooms, bio filter)



There is no quarantine in effect to slow/stop the movement of GSOB or K/PSHB infested wood at this point...



- APHIS/CDFA/County Ag
- How to enforce & fund
- Other possible players
- EAB quarantine
- Industry self-regulate
- Consumer awareness
- Treating wood
- Wood certification
- Wood exchange

www.dontmovefirewood.org



AYUDA A DETENER LA DISEMINACIÓN DE INSECTOS INVASIVOS Y ENFERMEDADES INVASIVAS

El Escarabajo barrenador del Roble con Manchas Doradas (GSOB) es un insecto invasivo. Se introdujo al condado de San Diego por la leña no nativa. Ha matado miles de robles. Ha afectado parques, bosques y áreas residenciales. GSOB podría matar millones de robles en California. Infórmese para que pueda ayudar a las agencias locales, estatales y federales a prevenir que esta peste se propague. Aprenda acerca de GSOB en la página de Internet www.gsob.org.

COMO USTED PUEDE AYUDAR:

- Deje la leña en casa – no mueva madera a los parques ni los campamentos
- Compre la leña en áreas locales.
- Solo lleve la cantidad de leña que va a necesitar.



COMPRE LA LEÑA DONDE SE VA A USAR



firewood.ca.gov



DON'T MOVE FIREWOOD.org

Don't Move Firewood

"Buy It Where You Burn It"

www.firewood.ca.gov



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OC Parks

USDA Forest Service/State and Private Forestry

CAL FIRE

California Avocado Commission