



Invasive Shot-Hole Borer and Fusarium Dieback

Field Guide

Identifying Signs and Symptoms of
Polyphagous and Kuroshio Shot-Hole Borer



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Images

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(a) (b) Gevork Arakelian, *LA County Dept. of Agriculture*
(d) Mike Lewis, *UC Riverside*

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(a) (b) Jack K. Clark, *UC IPM*

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(a), (c) Jack K. Clark, *UC IPM*

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Mesquite: Tim Thibault

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p. 21, White alder: Keir Morse

p. 27, Castor bean: Monica Dimson

p. 45, Camellia: Monica Dimson



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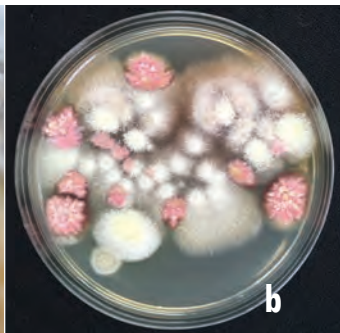


ISHB galleries in a castor bean branch.

Ornamental Host Species

- | | | | |
|--------------|--|--------------|---|
| 29 | Acacia
<i>Acacia</i> spp. | 37 | English oak
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Background



Beetle/Fungal Complex

The Invasive Shot-Hole Borers (ISHB), *Euwallacea* spp., are invasive beetles that vector a plant disease called Fusarium Dieback (FD). "ISHB" refers collectively to the **Polyphagous and Kuroshio Shot-Hole Borers**.

Over 260 plant species have been attacked by ISHB-FD. The disease disrupts the flow of water and nutrients in susceptible hosts, which can lead to the death of individual branches or, in severe cases, the entire tree. It is caused by the fungi that the beetle uses as a food source: *Fusarium euwallaceae*, *Graphium euwallaceae*, and *Paracremonium pembeum*.

(a) Adult female burrowing into wood; (b) Colonies of symbiotic fungi recovered from the beetle in the lab

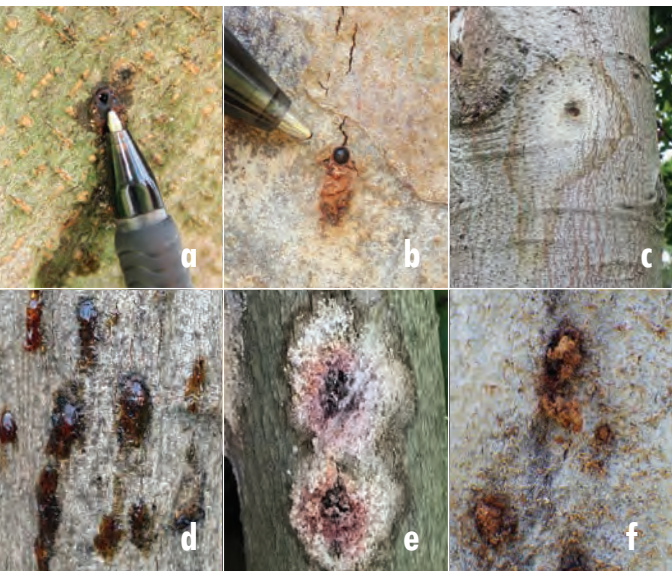
Beetle Biology and ID



ISHB bore tunnels (galleries) into host trees, which is where they lay their eggs and grow the fungi. The two beetle species are physically identical.

At 1.8-2.5 mm long, ISHB adult beetles are smaller than a sesame seed. The adult females (a) are larger than the adult males (b), and are also darker in color (c). Most of the beetle's life cycle, from larva to adult (d), is spent in the galleries. Mature siblings mate with each other so that females are already pregnant when they leave to start their own galleries.

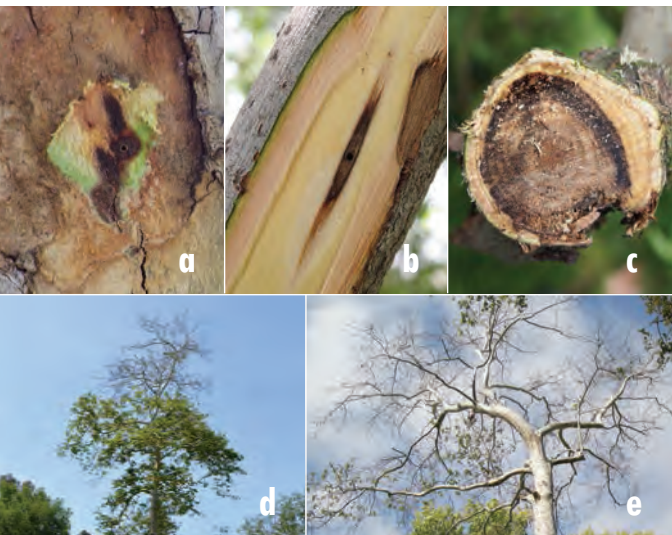
Signs and Symptoms



Entry-holes are round and ~ 0.85 mm wide, about the size of a ball-point pen tip (a). The abdomen of the female beetle may be seen sticking out of the hole (b).

Tree symptoms are unique to each host species. Around the entry-hole, look for dark, wet staining that sometimes dries to white or yellow (c); thick gumming (d); white, powdery exudate (e); and/or frass (f), which resembles sawdust.

Signs and Symptoms



Signs of Infection by *Fusarium* Dieback include brown to black discoloration on wood beneath the bark. Scrape away bark around the entry/exit hole to reveal dark staining surrounding the gallery (a, b). Cross-sections of cut branches (c) show the extent of infection.

Branch Dieback is the result of advanced *Fusarium* infections. It may begin on a few branches (d) and eventually kill entire trees (e).

Look-Alikes

Look out for other insects and fungi that cause damage similar to that of ISHB-FD. Some clues that may indicate a pest other than ISHB include:

- Staining, gumming, or exudate, but NO entry-hole
- Entry-holes with an irregular shape (i.e. not round)
- Entry-holes larger or smaller than a ball-point pen tip
- The tree is not a known host of ISHB-FD (e.g. pine or most eucalyptus species)

Visit ipm.ucanr.edu to learn more about these pests.



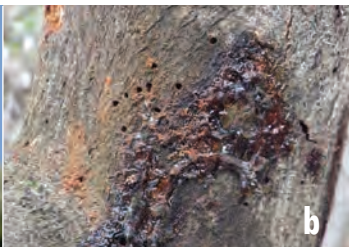
Foamy bark canker, caused by *Geosmithia* species #41

Western oak bark beetle, *Pseudopityophthorus pubipennis*

Hosts: Coast live oak; stressed or dying trees

Look for: beetles 1.7-2.3 mm long (a); reddish frass (b), reddish sap, wet discoloration, and/or foamy liquid (c) from smaller entry-hole than that of ISHB; dead tissue around entry hole, beneath bark (d)

Look-Alikes



Fruit tree shot-hole borer, *Scolytus rugulosus* (a)

Hosts: Fruit and nut trees, English laurel

Look for: entry-holes oozing sap or frass-the holes are larger than those of ISHB with slightly rougher edges (b); exit-holes are sap free

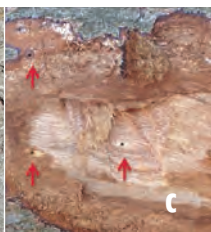
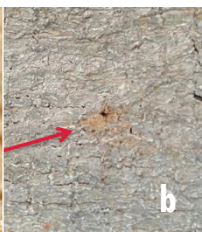


Western sycamore borer, *Synanthedon resplendens*

Hosts: Species of sycamore, oak, and ceanothus

Look for: larvae 25-38 mm long (c); roughened bark (d); reddish sawdust-like frass and/or pupal cases (e) in bark crevices or on ground; bleeding

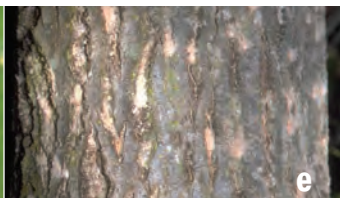
Look-Alikes



Lesser ambrosia beetle, *Xyleborinus saxeseni*

Hosts: Stressed and dying trees

Look for: beetles 2-2.4 mm long (a); smaller entry holes than those of ISHB (b); reddish frass and/or sap; wet discoloration and/or dead tissue around entry hole and beneath bark (c)

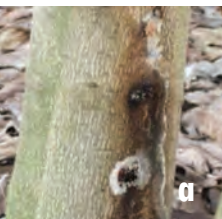


Oak ambrosia beetles, *Monarthrum dentiger*, *M. scutellare* (d)

Hosts: Oak species, tanoak, CA buckeye

Look for: slightly larger beetles (*M. scutellare*: 3.5-4.1 mm long, *M. dentiger*: 1.9-2.4 mm) and entry-holes (1-1.5 mm diameter) with bleeding, frothing, bubbling, or white boring dust (e) that is tan when oxidized; often attack stressed trees

Look-Alikes



a



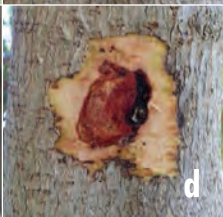
c



e



b



d



f

Avocado trunk canker, caused by *Phytophthora mengei* (a, b)

Bacterial canker, caused by *Xanthomonas campestris* (c, d)

Black streak disease, caused by *Botryosphaeria* spp. (e, f)

Avocado branch canker and dieback, caused by *Botryosphaeria* spp. and *Phomopsis* sp. (g, h)



g



h

Host Species

Reproductive host species support beetle reproduction and growth and development of the symbiotic fungi. Each species is affected differently; the most susceptible hosts are shown in **bold text** below. This is **not** a do-not-plant list. Visit www.pshb.org for updates.

California Natives

Arroyo willow (*Salix lasiolepis*), **Big leaf maple** (*Acer macrophyllum*), **Black cottonwood** (*Populus trichocarpa*), Blue palo verde (*Cercidium floridum*), **Box elder** (*Acer negundo*), California buckeye (*Aesculus californica*), **California sycamore** (*Platanus racemosa*), Canyon live oak (*Quercus chrysolepis*), Coast live oak (*Quercus agrifolia*), Engelmann oak (*Quercus engelmannii*), **Fremont cottonwood** (*Populus fremontii*), Goodding's black willow (*Salix gooddingii*), Mesquite (*Prosopis articulata*), Mulefat (*Baccharis salicifolia*), **Red willow** (*Salix laevigata*), Valley oak (*Quercus lobata*), White alder (*Alnus rhombifolia*)

Invasive Species

Castor bean (*Ricinus communis*), Tamarix (*Tamarix ramosissima*), Tree of heaven (*Ailanthus altissima*)

continued on page 14

Host Species

Reproductive Hosts, cont.

Agricultural Species

Avocado (*Persea americana*), Black mission fig (*Ficus carica*)

Ornamental Species

Acacia (*Acacia* spp.), American sweetgum (*Liquidambar styraciflua*), **Black poplar** (*Populus nigra*), Brea (*Cercidium sonora*), Camellia (*Camellia semiserrata*), Carrotwood (*Cupaniopsis anacardioides*), Chinese holly (*Ilex cornuta*), Coral tree (*Erythrina corallodendron*), Cork oak (*Quercus suber*), **English oak** (*Quercus robur*), Evergreen maple (*Acer paxii*), Japanese beech (*Fagus crenata*), Japanese maple (*Acer palmatum*), Japanese wisteria (*Wisteria floribunda*), Kentia palm (*Howea forsteriana*), King palm (*Archontophoenix cunninghamiana*), Kurrajong (*Brachychiton populneus*), **London plane** (*Platanus x acerifolia*), **Mexican sycamore** (*Platanus mexicana*), Mimosa/Silk tree (*Albizia julibrissin*), Moreton Bay chestnut (*Castanospermum australe*), Palo verde (*Parkinsonia aculeata*), Red flowering gum (*Eucalyptus ficifolia*), Shiny xylosma (*Xylosma congestum*), Titoki (*Alectryon excelsus*), Trident maple (*Acer buergerianum*), Weeping willow (*Salix babylonica*)

Big Leaf Maple



Acer macrophyllum
Native reproductive host

◀ LEAF ID

Symptoms
Staining

Box Elder



Acer negundo
Native reproductive host

LEAF ID ►

Symptoms

Staining, bleeding, frass



California Sycamore



Platanus racemosa
Native reproductive host

← LEAF ID

Symptoms
Staining

Red Willow



Salix laevigata
Native reproductive host

LEAF ID ►

Symptoms
Staining, frass



Goodding's Black Willow



Salix gooddingii
Native reproductive host

← LEAF ID

Symptoms
Staining

Fremont Cottonwood



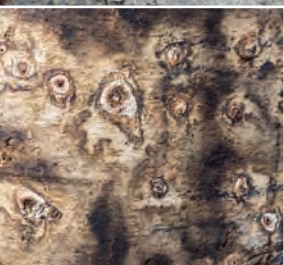
Populus fremontii
Native reproductive host

LEAF ID ➤

Symptoms
Staining



White Alder



Alnus rhombifolia
Native reproductive host

◀ LEAF ID

Symptoms
Staining

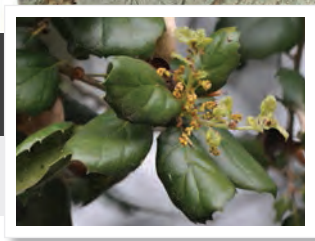
Coast Live Oak



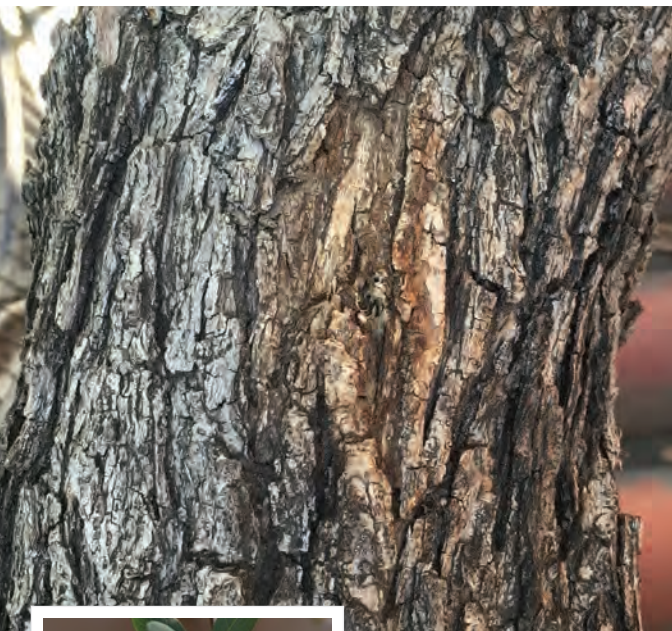
Quercus agrifolia
Native reproductive host

LEAF ID >

Symptoms
Staining



Engelmann Oak



Quercus engelmannii
Native reproductive host

◀ LEAF ID

Symptoms
Staining



Valley Oak



Quercus lobata
Native reproductive host

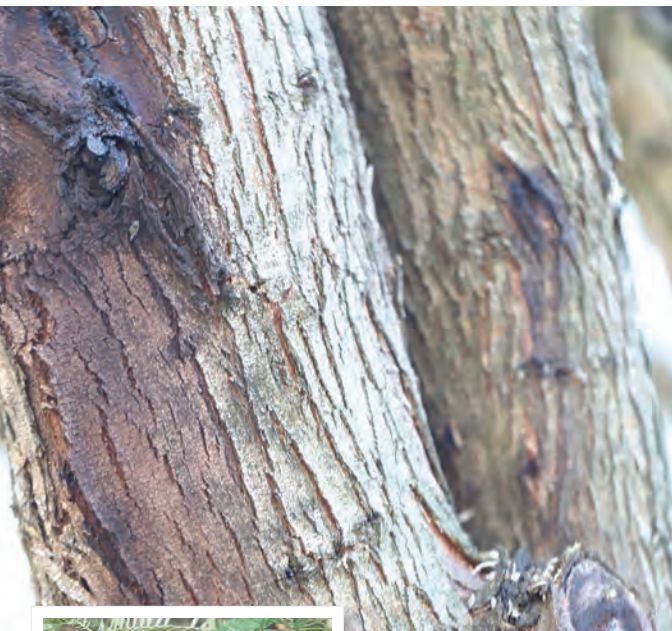
LEAF ID ►

Symptoms

Staining



Mesquite



Prosopis articulata
Native reproductive host

◀ LEAF ID

Symptoms
Staining



Tree of Heaven



Ailanthus altissima
Invasive reproductive host

LEAF ID ►

Symptoms
Staining



Castor Bean



Ricinus communis
Invasive reproductive host

◀ LEAF ID

Symptoms
Staining



Avocado



Persea americana
Reproductive host

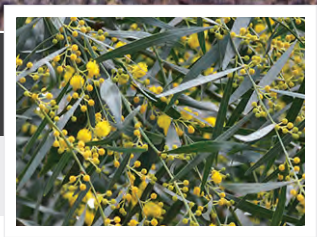
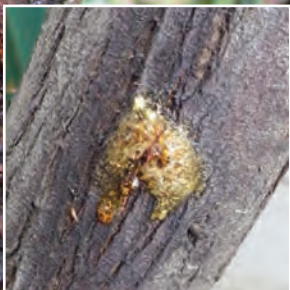
LEAF ID ➤

Symptoms

Sugary exudate, staining



Acacia



Acacia spp.
Reproductive host

◀ LEAF ID

Symptoms
Gumming, staining

Silk Tree/Mimosa



Albizia julibrissin
Reproductive host

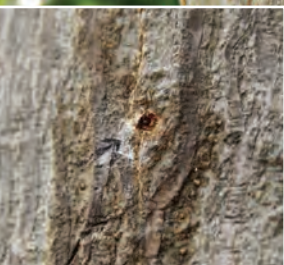
LEAF ID >

Symptoms

Staining, gumming



Coral Tree



Erythrina corallodendron
Reproductive host

◀ LEAF ID

Symptoms
Staining

Palo Verde



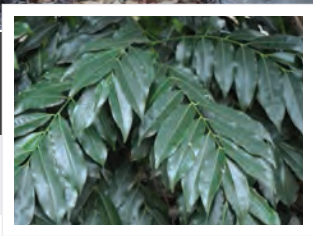
Parkinsonia aculeata
Reproductive host

LEAF ID ►

Symptoms
Staining, frass



Moreton Bay Chestnut



Castanospermum australe
Reproductive host

◀ LEAF ID

Symptoms

Staining, gumming

Chinese Flame/Goldenrain



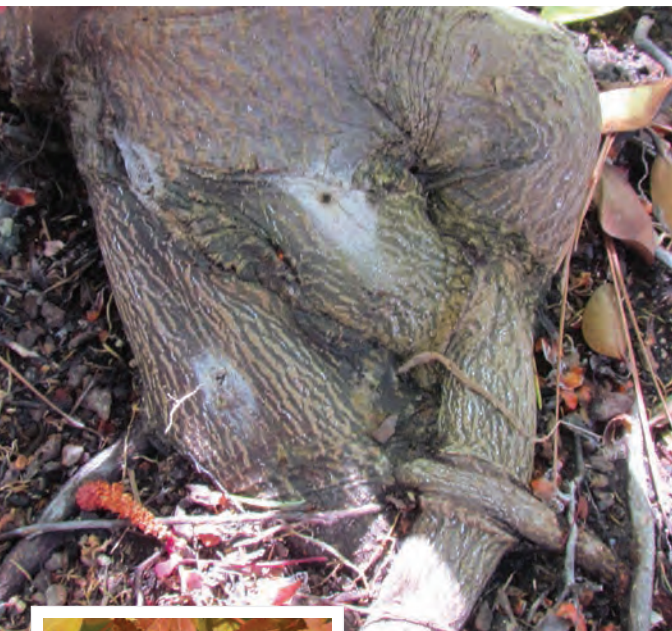
Koelreuteria bipinnata,
K. paniculata
FD-susceptible hosts
LEAF ID (*K. BIPINNATA*) ➤

Symptoms

Gumming , staining



Japanese Maple



Acer palmatum
Reproductive host

◀ LEAF ID

Symptoms
Staining

Trident Maple



Acer buergerianum
Reproductive host

LEAF ID >

Symptoms
Staining



English Oak



Quercus robur
Reproductive host

◀ LEAF ID

Symptoms
Staining

Cork Oak



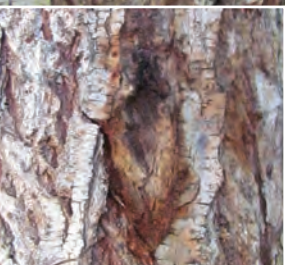
Quercus suber
Reproductive host

LEAF ID ▶

Symptoms
Staining



Weeping Willow



Salix babylonica
Reproductive host

◀ LEAF ID

Symptoms

Staining, gumming, frass

Shiny Xylosma



Xylosma congregatum
Reproductive host

LEAF ID ►

Symptoms
Staining



American Sweetgum



Liquidambar styraciflua
Reproductive host

← LEAF ID

Symptoms
Staining



Kurrajong



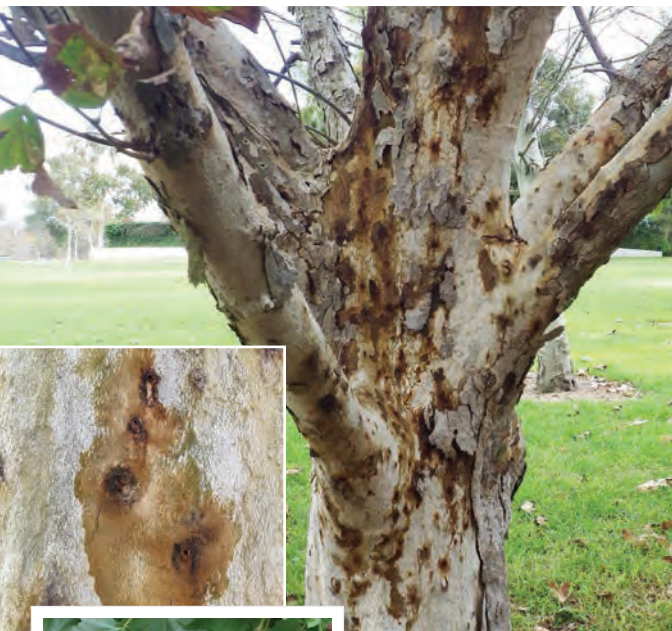
Brachychiton populneus
Reproductive host

LEAF ID ►

Symptoms
Gumming



London Plane



Platanus x acerifolia
Reproductive host

◀ LEAF ID

Symptoms
Staining



Kentia Palm



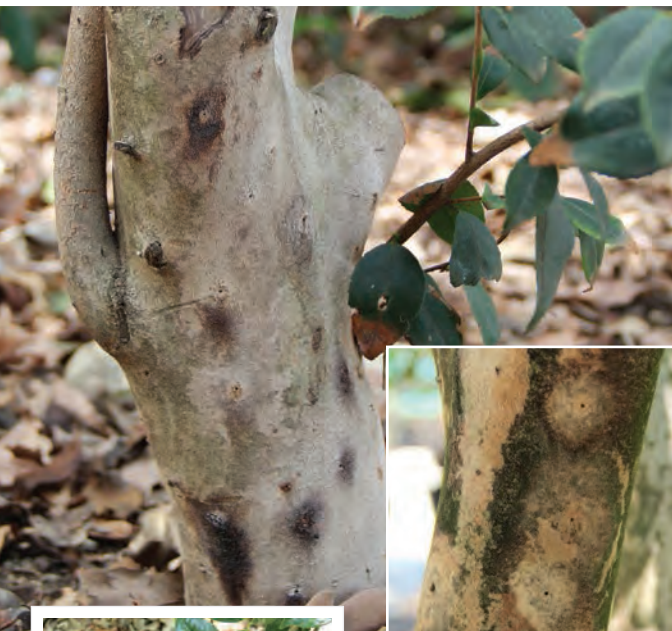
Howea forsteriana
Reproductive host

LEAF ID >

Symptoms
Gumming, frass



Camellia



Camellia semiserrata
Reproductive host

◀ LEAF ID

Symptoms
Staining



Report a Suspect Tree

As of March 2017, ISHB-FD has been detected in Los Angeles, Orange, Riverside, San Diego, San Bernardino, Ventura, Santa Barbara, and San Luis Obispo Counties. Please report suspected tree infestations in California to the Eskalen Lab at UC Riverside at:

eskalenlab@gmail.com

Submit the following information:

- Your contact information (name, city, phone number and/or email depending on method of submission)
- Suspect tree species
- Description of suspect tree's location (and/or GPS coordinates)
- Description of suspect tree's symptoms
- Photos of suspect tree and close-up photos of symptoms (**see examples on page 47**)

Based on the symptom description and photos, UC Riverside will decide whether a field assessment is needed to confirm the infestation.

A suspect tree reporting form can be downloaded at:

eskalenlab.ucr.edu

Report a Suspect Tree



Take pictures of suspect trees from several distances. Include clear, in-focus photos of:

1. the trunk or symptomatic branches
2. the symptoms (close-up)
3. the entry/exit hole, if visible, with a ballpoint pen for scale (remove gumming or exudate if necessary)

If dieback is observed, include a picture of the entire tree. Attach these photos to the Suspect Tree Report that is sent to UC Riverside.



**Find additional ISHB-FD
info, research, and news at:**

pshb.org
eskalenlab.ucr.edu

References

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Stouthamer, R. et al. (2017) in *Agricultural and Forest Entomology*.

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