Invasive Shot Hole Borer

DREW RAYMOND-DEPUTY AGRICULTURAL COMMISSIONER

SANTA CLARA COUNTY

Invasive Shot Hole Borer(s)

There are currently 2 species of ISHB in California

- Polyphagus shothole borer (*Euwallacea fornicates*)
- Kuroshio shothole borer (*Euwallacea Kuroshio*)

Both species “farm” fungus for food.

- The two beetles are very morphologically similar, but can be ID, by the species of fungus they farm in the galleries.

The fungus that they farm eventually kill the host tree.

- Fusarium wilt and dieback

Figure 1: Adult female (left) and male (right) invasive shothole borer beetles.

Figure 2: Female (right) and male (left) ISHB adults on a US penny.

Identification

ISHB can most easily be identified by the exit hole from the galleries

- Gallery holes are the size of a ball point pin
- They are perfectly round and about 0.85mm in diameter

Identification

Suspect infestation of ISHB can also be identified by the symptoms from the host.

- Trees under attack will look like they have been shot with a shot gun
- Some species will ooze fluid out in an effort to exude the beetle
- Cross sections of the wood will show black galleries infested with the fungus they farm.

Identification

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The most positive way to identify ISHB is to culture the fungus that they farm.

- The polyphagous shothole borer is associated with Fusarium euwallaceae, Graphium euwallaceae, and Acremonium pembeum.
- The Kuroshio shothole borer is associated with Fusarium kuroshium and Graphium kuroshium.

Figure 2

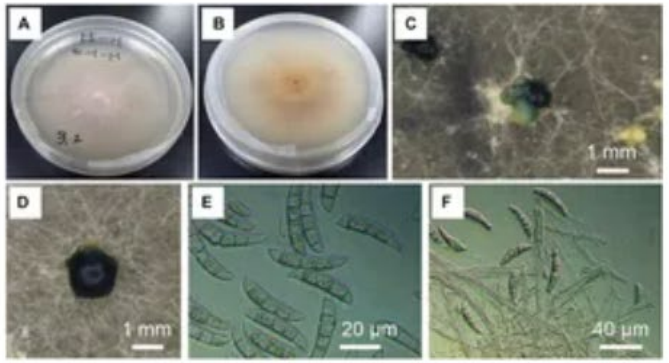


Figure 2. Morphological characteristics of *Fusarium kuroshium*. **(A,B)** Colony on potato dextrose agar (PDA) at 25°C 10 days after inoculation. **(C,D)** Greenish conidial masses formed on sporodochia in culture on PDA (25°C, dark, 2 months). **(E)** Conidial spores in the colony on PDA (25°C, dark, 2 months). **(F)** Conidial spores in the colony on synthetic low-nutrient agar (25°C, dark, 1 month).

A bit about Fungus

- ISHB “farms” the symbiotic fungus in the galleries of the host trees.
- They disperse from their host with spores of the fungus in their mouth parts.
- The host tree will eventually die from the Fusarium species infecting the tree.
- Once the host dies, the tree can no longer support Fusarium growing and the beetle leave the host.

Figure 1

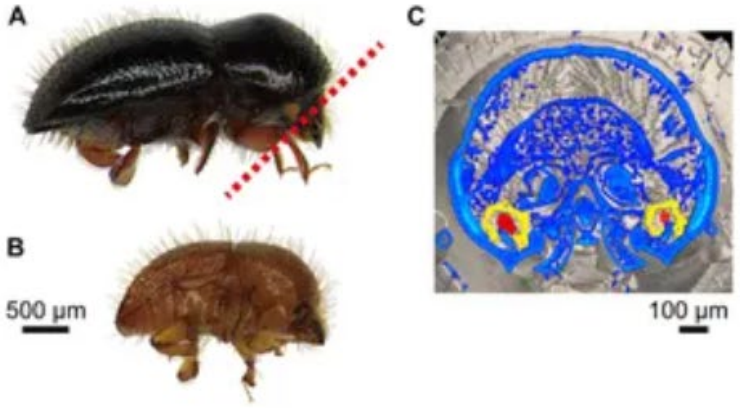


Figure 1. Adult *Euwallacea interjectus*. **(A)** Female and **(B)** male in lateral view. **(C)** Cross-sections of oral mycangia (colored in yellow) with compacted fungal inoculum (colored in red) in female from red dotted line in panel **(A)** by micro-computed tomography scan in Jiang et al. (2019) (unpublished image).

History of ISHB

Originally native to Vietnam and Taiwan

- 2003 found in LA, but mis identified
- 2013 found in a backyard avocado tree and has since spread in Southern California to Los Angeles, Orange, and Riverside Counties and has also spread to San Bernardino, Ventura, and Santa Barbara Counties.
- 2014 a single beetle was found in a trap in Santa Cruz County, no others found there
- 2016 a single beetle was found in a trap in San Louis Obispo, no others found there

ISHB Host list

Hosts killed by ISHB-FD

Latin Name	Common Name
Acer buergerianum	Trident maple
Acer macrophyllum	Big leaf maple*
Acer negundo	Box elder*
Acer palmatum	Japanese maple
Liquidambar styraciflua	American sweet gum
Parkinsonia aculeata	Palo verde
Platanus racemosa	California sycamore*
Platanus x acerifolia	London plane
Populus fremontii	Fremont cottonwood*
Populus nigra	Black poplar*
Populus trichocarpa	Black cottonwood*
Quercus lobata	Valley oak*
Quercus robur	English oak
Ricinus communis	Castorbean
Salix gooddingii	Black willow*
Salix laevigata	Red willow*
Salix lasiolepis	Arroyo willow*

Hosts NOT killed by ISHB-FD

Latin Name	Common Name
Acacia melanoxylon	Australian blackwood
Acacia mearnsii	Black wattle†
Acacia spp.	Acacia
Acer paxii	Evergreen maple
Acer saccharinum	Silver leaf maple
Aesculus californica	California buckeye*
Ailanthus altissima	Tree of heaven
Albizia julibrissin	Mimosa
Alectryon excelsus	Titoki
Alnus rhombifolia	White alder*
Archontophoenix cunninghamiana	King palm
Baccharis salicina	Mule fat*
Baccharis pilularis	Coyote bush
Bauhinia variegata	Purple orchid tree
Brachychiton populneus	Kurrajong
Camellia semiserrata	Camellia
Castanospermum australe	Moreton Bay chestnut
Casuarina equisetifolia	Australian pine tree
Cercidium floridum	Blue palo verde*
Cercidium x sonorae	Sonoran palo verde

ISHB Host list

Hosts NOT killed by ISHB-FD

Latin Name	Common Name
Cocculus laurifolius	Laurel leaf snailseed tree
Combertum kraussii	Forest bushwillow†
Corymbia ficifolia	Red flowering gum
Cupaniopsis anacardioides	Carrotwood
Dombeya cacuminum	Strawberry tree
Erythrina caffra	Coast coral tree
Erythrina coralloides	Coral tree
Erythrina falcata	Brazilian coral tree
Fagus crenata	Japanese beech
Ficus altissima	Council tree
Ficus carica	Black mission fig
Gleditsia triacanthos	Honey locust
Harpullia pendula	Tulip wood
Howea forsteriana	Kentia palm
Ilex cornuta	Chinese holly
Jacaranda mimosifolia	Jacaranda
Koelreuteria bipinnata	Chinese flame tree
Magnolia grandiflora	Southern magnolia
Magnolia virginiana	Sweet bay
Persea americana	Avocado
Platanus mexicana	Mexican sycamore
Podalyria calyptrata	Keurtije†
Populus tremuloides	Quaking aspen
Prosopis articulata	Mesquite*
Psoralea pinnata	Fountain bush†
Pterocarya stenoptera	Chinese wingnut
Ptychosperma elegans	Solitaire palm
Quercus agrifolia	Coast live oak*
Quercus chrysolepis	Canyon live oak*
Quercus engelmannii	Engelmann oak*
Quercus macrocarpa	Bur oak
Quercus suber	Cork oak
Salix alba	White willow†
Salix babylonica	Weeping willow
Spathodea campanulata	African tulip tree
Salix mucronate	Cape silver willow†
Tamarix ramosissima	Tamarisk
Virgilia oroboides	Tree-In-A-Hurry†
Wisteria floribunda	Japanese wisteria
Xylosma congesta	Dense logwood / Shiny Xylosma

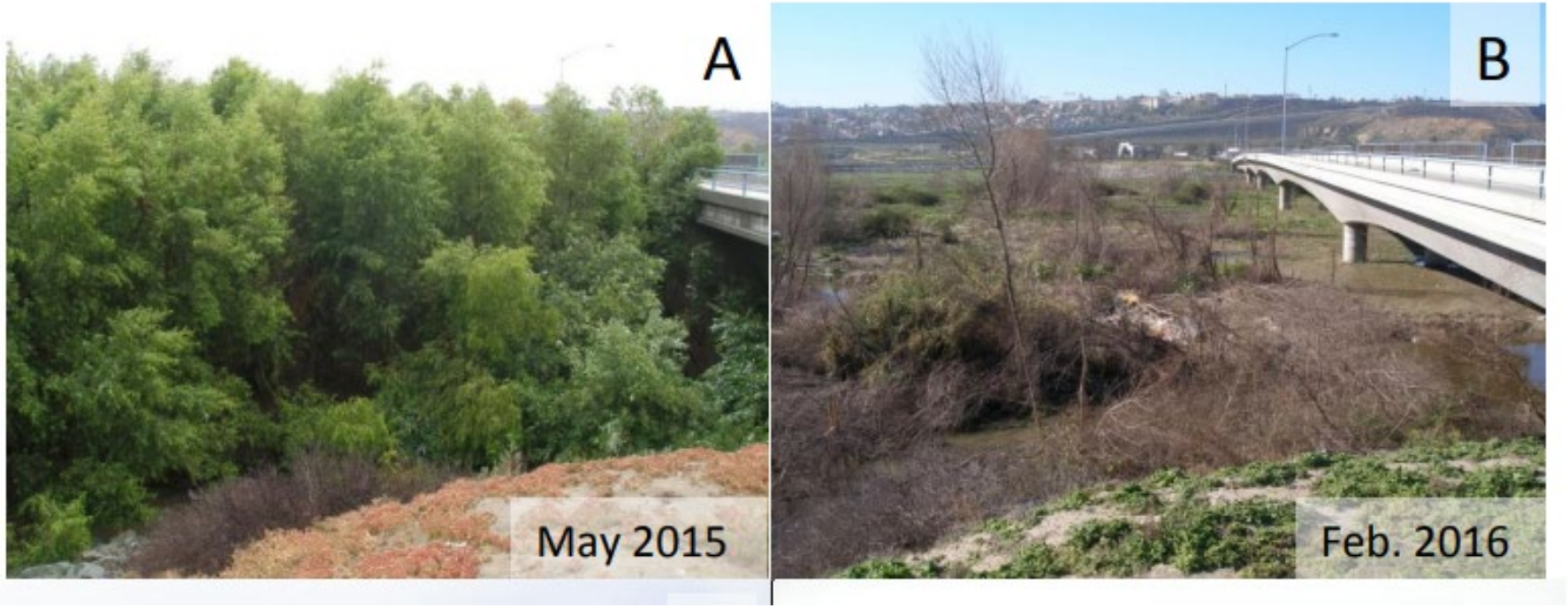
Infestation in Southern California

Blue=Not detected

Red=detected

Damage in Southern California

Tijuana river riparian area



Damage in Southern California

Damage in Southern California

Welcome to San Jose!

First discovery

In November 2023, an arborist working in the area recognized ISHB damage

They sampled for the beetle and alerted the CAC

The suspect was ID by CDFA staff as ISHB

Other locations

- City of San Jose was made aware
- The City requested CAC staff sample a City tree that was tagged for removal due to disease on Empire Street near downtown
- The beetle was sent to CDFA and a wood sample was also sent for analysis of the symbiotic fungus

Identifications

Lab Entomology	Scientist Alexey Tishechkin	Rating B	Common Name scolytid beetle
Date 1/11/2024	Order Coleoptera	Family Curculionidae	
Genus Euwallacea		Species sp.	
Sub-Species		Higher Category (phylum) Arthropoda, (class) Insecta	
General Identification Notes			

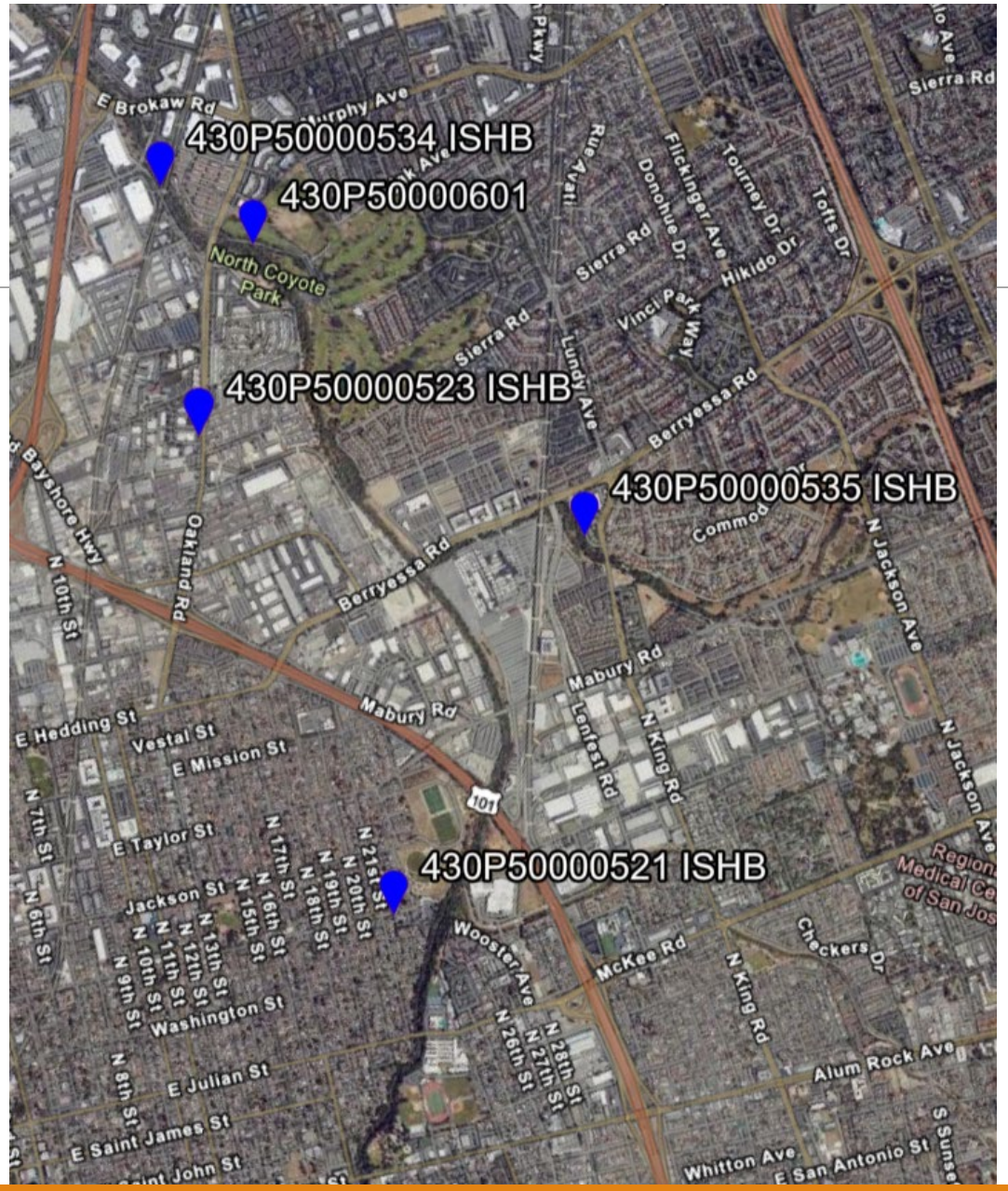
Other locations

- CAC staff informally surveyed around the two find sites and found more infested trees
- Large amplifier trees were found along Oakland Rd
- Box elder trees were located on iNaturalist and surveyed

Other locations

One box elder near our office was located and found dead

Other locations



ISHB Management

Early detection is key to control ISHB in small populations

Multiple trap types exist to monitor for ISHB (Sticky panel and Lindgren)

ISHB Management

Once ISHB has been detected in a tree the appropriate level of control should be selected from the UC IPM matrix

ISHB Infestation Level & Management Options for Low Value Trees

Host Type	Hazard Level	No Infestation	Low Infestation	Moderate Infestation	Heavy Infestation	Severe Infestation
Reproductive Host	Low	Monitor	Monitor	Monitor & remove infested branches*	Monitor & remove infested branches*	Remove tree & stump
Reproductive Host	High	Monitor	Monitor & remove hazard branches	Monitor & remove infested/hazard branches*	Remove infested/ hazard branches*, or remove tree & stump	Remove tree & stump
Non-Reproductive Host	Low	Monitor	Monitor	Notify your local UCCE office; consult with ISHB-FD experts to determine if species is a new reproductive host		
Non-Reproductive Host	High	Monitor	Monitor	Notify your local UCCE office; consult with ISHB-FD experts to determine if species is a new reproductive host		

ISHB Management

ISHB Infestation Level & Management Options for High Value Trees

Host Type	Hazard Level	No Infestation	Low Infestation	Moderate Infestation	Heavy Infestation	Severe Infestation
Reproductive Host	Low	Monitor	Treat and/or remove infested branches*	Treat and/or remove infested branches*	Treat and/or remove infested branches*	Remove tree & stump
Reproductive Host	High	Monitor	Treat and/ or remove infested/hazard branches*	Treat and/or remove infested branches*	Remove infested branches*, or remove tree & stump	Remove tree & stump
Non-Reproductive Host	Low	Monitor	Monitor	Notify your local UCCE office; consult with ISHB-FD experts to determine if species is a new reproductive host		
Non-Reproductive Host	High	Monitor	Monitor	Notify your local UCCE office; consult with ISHB-FD experts to determine if species is a new reproductive host		

ISHB Management

Removal of the tree is the best management

For High value trees, treatment may help to save the tree

- Chemical treatment will have to be repeated over the life of the tree

Once the tree is removed stump grinding is recommended

- Stumps can graft to other trees and continue to act as a host

Special care must be taken when the tree is removed

- Tree material must be chipped to 1’’ or less to kill the beetle

ISHB Management

Once chipped the material should be covered during transportation

The material should be solarized and/or composted

ISHB Management

Chemical treatment is limited

- Bifenthrin
- Bacillus subtilis (requires a respirator)
- Soil drench of imidacloprid
- Injection of emamectin benzoate (insecticide) and propiconazole (fungicide)

- https://youtu.be/H8bdgWA0JHk

- https://www.youtube.com/watch?v=cNPuZUiKz1g

How does it spread

Invested wood material

- Firewood
- Crafting wood

Sources

https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2021.725210/full

https://ucanr.edu/sites/pshb/