Least Bell’s Vireo - Shot Hole Borer in California

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Invasive Pests and Impacts

Emerald Ash Borer

Chestnut blight
The insect vector was first detected in California in 2003 in CDFA’s funnel traps in Los Angeles.

Problem was not recognized until 2012 when discovered on a backyard avocado tree in Los Angeles.

Second invasion in late 2014 in San Diego County.
Shot Hole Borer and Symbiotic Fungi

Polyphagous Shot Hole Borer (PSHB)

Fusarium euwallaceae (Freeman et al. 2013)
Graphium euwallaceae (Lynch et al. 2015)
Paracremoneum pembeum (Lynch et al. 2015)

Fusarium Dieback: Disease Progress
Branch Dieback and Wilt

English Oak (*Quercus robur*)  
Box Elder (*Acer negundo*)
### Host Range of Shot Hole Bore and Fusarium Dieback

<table>
<thead>
<tr>
<th>Tree Species Attacked by Beetle</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>California box elder (Acer negundo)*</td>
<td>286</td>
</tr>
<tr>
<td>Coast live oak (Quercus agrifolia)</td>
<td>117</td>
</tr>
<tr>
<td>California Sycamore (Platanus racemosa)</td>
<td>286</td>
</tr>
<tr>
<td>Big leaf maple (Acer macrophyllum)</td>
<td>117</td>
</tr>
<tr>
<td>Avocado (Persea americana)*</td>
<td>56</td>
</tr>
<tr>
<td>Red Willow (Salix leevigata)*</td>
<td>19</td>
</tr>
<tr>
<td>Persimmon (Diospyros spp.)*</td>
<td>19</td>
</tr>
<tr>
<td>California bay laurel (Umbellularia californica)</td>
<td>19</td>
</tr>
<tr>
<td>Mexican sycamore (Platanus mexicana)</td>
<td>19</td>
</tr>
<tr>
<td>Olive (Olea europaea)</td>
<td>19</td>
</tr>
<tr>
<td>Arroyo willow (Salix lasolepis)*</td>
<td>19</td>
</tr>
<tr>
<td>Citrus (Citrus spp.)*</td>
<td>19</td>
</tr>
<tr>
<td>California Persimmon (Diospyros lycioides)</td>
<td>19</td>
</tr>
<tr>
<td>Canyon live oak (Quercus chrysolepis)</td>
<td>19</td>
</tr>
<tr>
<td>Desert fan palm (Washingtonia filifera)</td>
<td>19</td>
</tr>
<tr>
<td>Grapevine (Vitis vinifera)</td>
<td>19</td>
</tr>
<tr>
<td>California buckeye (Aesculus californica)</td>
<td>19</td>
</tr>
<tr>
<td>Coffee berry (Rhamnus californica)</td>
<td>19</td>
</tr>
<tr>
<td>Cassava (Manihot esculenta)</td>
<td>19</td>
</tr>
<tr>
<td>Velvet ash (Fraxinus velutina)</td>
<td>19</td>
</tr>
<tr>
<td>Japanese Persimmon (Diospyros kaki)</td>
<td>19</td>
</tr>
<tr>
<td>Fremont cottonwood (Populus fremontii)</td>
<td>19</td>
</tr>
<tr>
<td>Japanese crabapple (Malus floribunda)</td>
<td>19</td>
</tr>
<tr>
<td>California ash (Fraxinus dipetala)</td>
<td>19</td>
</tr>
<tr>
<td>Persimmon (Prunus spp.)*</td>
<td>19</td>
</tr>
<tr>
<td>Goodding’s black willow (Salix gooddingii)</td>
<td>19</td>
</tr>
<tr>
<td>Canyon Live Oak (Quercus chrysolepis)</td>
<td>19</td>
</tr>
</tbody>
</table>

**Agricultural Crops**: 13

**California Native Tree Species**: 11

**Number of Tree Families**: 56

**Number of Reproductive Hosts**: 19

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Female beetle attacks healthy host tree

Fungus causes branch dieback and tree mortality.

Fungus continues to colonize the wood beyond the gallery wall.

Beetles inoculate the fungus onto gallery wall.

Developing larvae feed on the fungus in the gallery. Young adults mate with siblings.

Females make galleries in the wood and lay eggs.

When the host dies, young adults leave the host to find a new host.
Reproductive host is home for the beetle family

- Larvae
- Young female
- Mature female
- Pupa
- Male
- Fungal colony on the gallery wall
Damage on Landscape Trees
How did they get to CA?

Pallets

Packing crates
Where did they come from?

Stouthamer et al. 2014, 2017
Spread of Fusarium Dieback-SHB

http://eskalenlab.ucr.edu/distribution
Shot Hole Borer (*Euwallacea* nr. *fornicatus*) and Symbiotic Fungi

- **Polyphagous Shot Hole Borer (PSHB)**
  - *Fusarium euwallacea* (Freeman et al. 2013)
  - *Graphium euwallacea* (Lynch et al. 2015)
  - *Paracremonium pembeum* (Lynch et al. 2015)

- **Kuroshio Shot Hole Borer (KSHB)**
  - *Fusarium kuroshium* (Na et al. 2017)
  - *Graphium kuroshium* (Na et al. 2017)

Spread of Fusarium Dieback-SHB

2003
2012
2013
2014
2015
2016
2017

○ PSHB
● KSHB
▲ TRAP

Distribution of Invasive Split Hole Borer - Fusarium Dieback in California
Affiliated Academic Units
The University of California, Berkeley
The University of California, Davis
The University of California, Santa Cruz

http://eskalenlab.ucr.edu/distribution
Attack Progress on Fremont Cottonwood

Late Summer 2014

Photo: Tom Coleman
Damage on Urban Forest

180,000 trees destroyed by this pest-disease infestation
Fusarium Dieback Impacts in Tijuana River Valley
The current situation in Tijuana River Valley

December 2015

December 2016

http://eskalenlab.ucr.edu/pshb.html
Implications for Endangered Wildlife Species

Least Bell’s vireo
www.allaboutbirds.org

Arroyo toad
www.californiaherps.com

Southwestern willow flycatcher
www.nrcs.usda.gov
Host Distribution

Arroyo Willow (Salix laseolepis.)
Beetle usually attack on the main trunk of host trees

Sycamore

Willow
KSHB in San Luis Rey Watershed in Bonsall
San Joaquin Marsh Wildlife Sanctuary Orange County
Santa Ana River Riparian Areas in Riverside County

http://eskalenlab.ucr.edu/pshb.html
Habitats Impacted

Native Plant Communities
- Mixed Evergreen
- Oak Woodlands
- Riparian

Urban Forests
- Parks
- Neighborhoods

Avocado Groves
Ecological modeling and adaptive management

- Establish monitoring plots in native vegetation to develop a prediction model for pest and disease pressure.
- We have already established long term monitoring plots in infested avocado orchards, the data that we have been collecting helps us develop best management practices on avocado.

Collaborating with Shannon Lynch, Greg Gilbert, Department of Environmental Studies, UC Santa Cruz
Fusarium-dieback Shot Hole Borers
Predicting risk in heterogeneous landscapes

Host Composition
Host Abundance
Microclimate

Lynch and Eskalen, 2018, Unpublished data
FD-SHB Distribution in San Luis Rey Monitoring Traps

Lynch and Eskalen 2018 Unpublished data
FD-SHB Distribution in San Luis Rey Monitoring Traps and Plots

Lynch and Eskalen, 2018, Unpublished data
Outcomes for Monitoring

• Early detection
• Document pest and disease impacts
• Determine where to allocate resources for management
• Identify endophytic organisms for biocontrol.

Collaborating with Shannon Lynch, Greg Gilbert, Department of Environmental Studies, UC Santa Cruz
www.eskalenlab.ucr.edu

www.pshb.org
Thank You

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