Invasive Shot Hole Borer and *Fusarium* in Southern California

Eskalen Lab, UC Riverside

IUWC
June 5, 2017

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Polyphagous and Kuroshio Shot Hole Borers (SHB)

An infestation involving the polyphagous (PSHB) and kuroshio (KSHB) shot hole borers, their associated fungi and other pathogens is causing widespread damage to trees throughout southern California. PSHB was first discovered in 2003 in LA and KSHB was first discovered in 2013 in San Diego. 2012 Avocado Industry responds.

Female

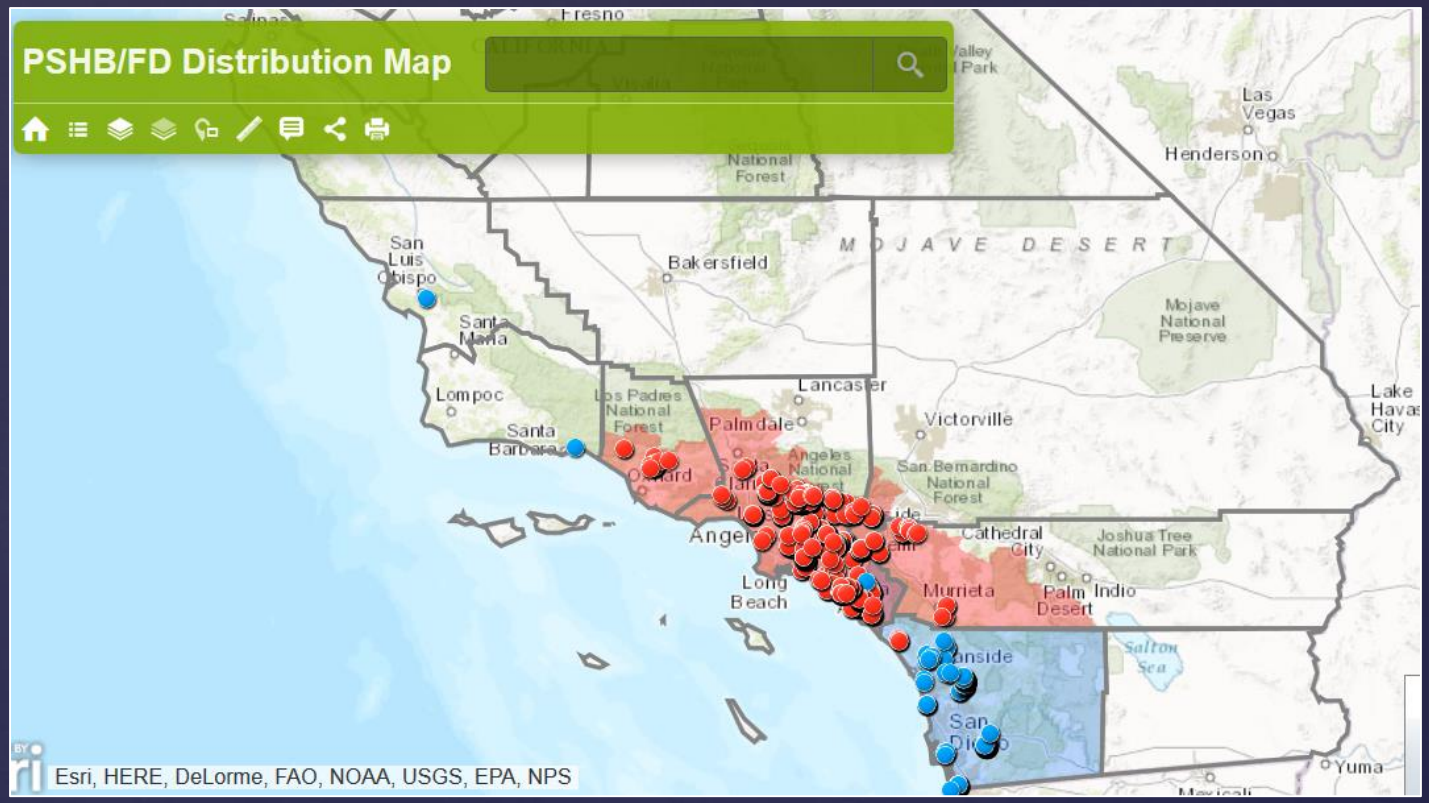
Male

PSHB probably originated in southeast Asia

KSHB is genetically similar to a beetle population in Taiwan.

SHB bore galleries into trees, inoculate with *Fusarium* fungi for feeding; other pathogens can also be introduced at this point

Current Distribution of Positively Identified SHB or *Fusarium*

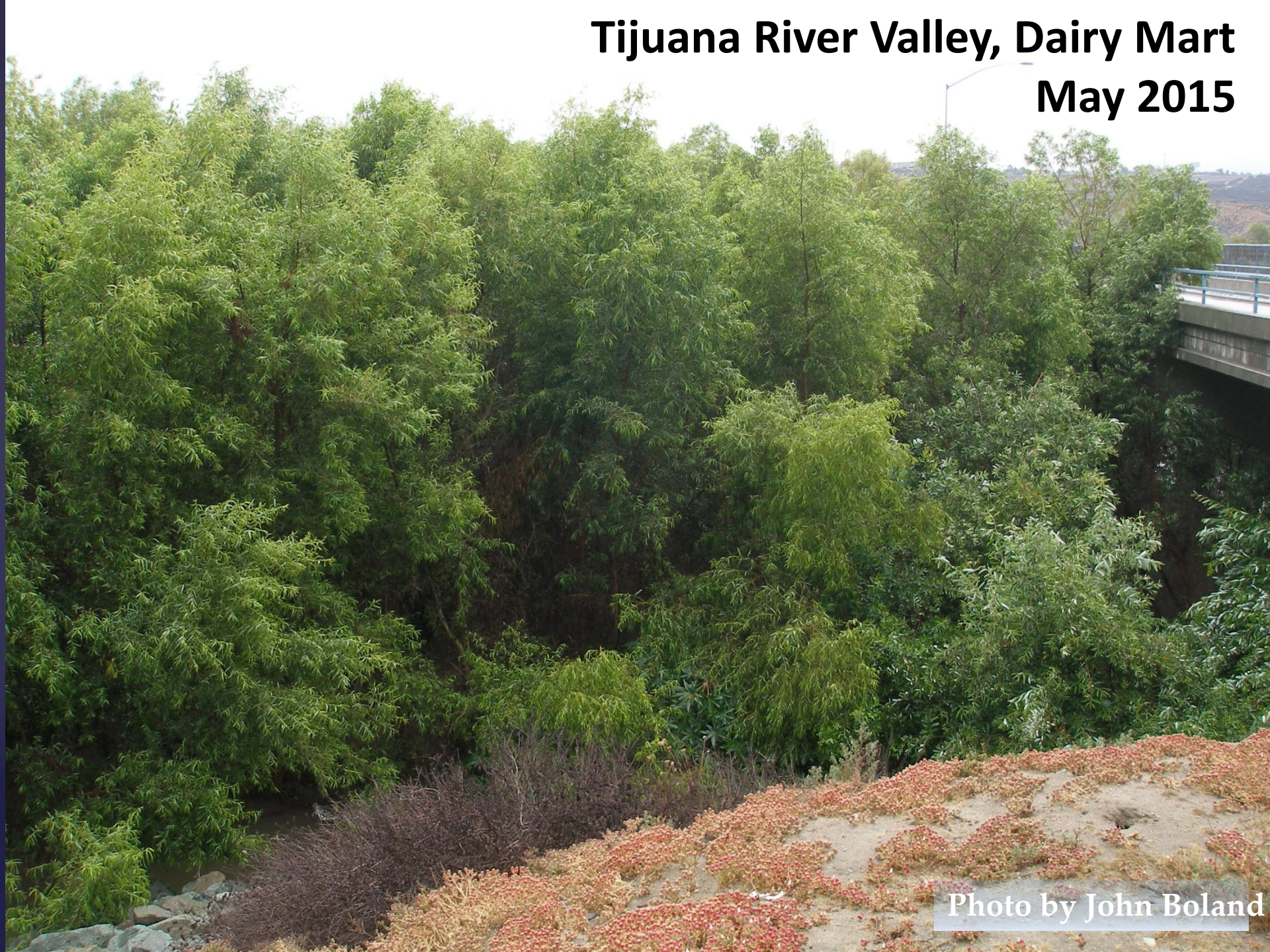


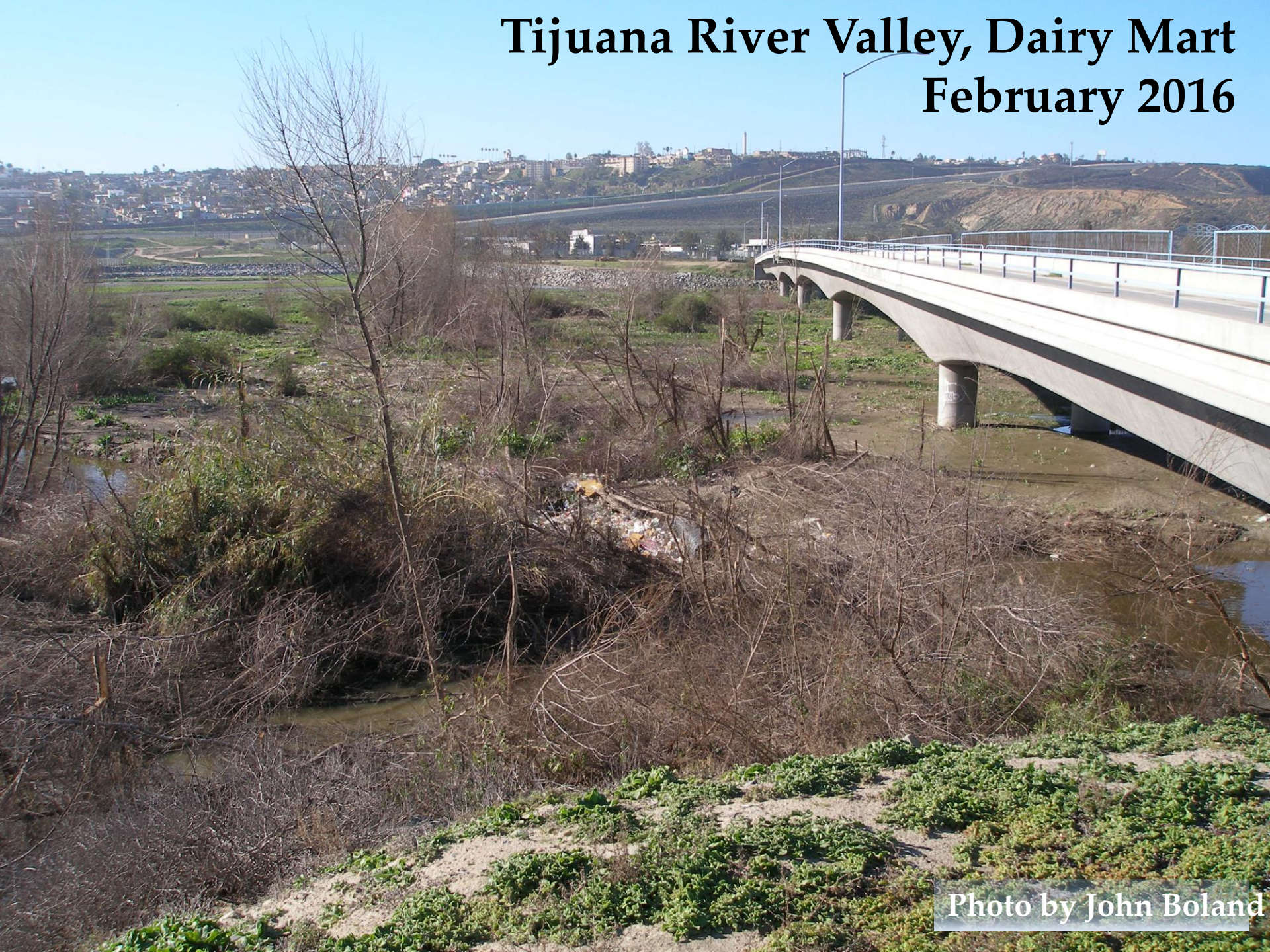
Source: Eskalen Lab, UC Riverside website, accessed 11/16/2016

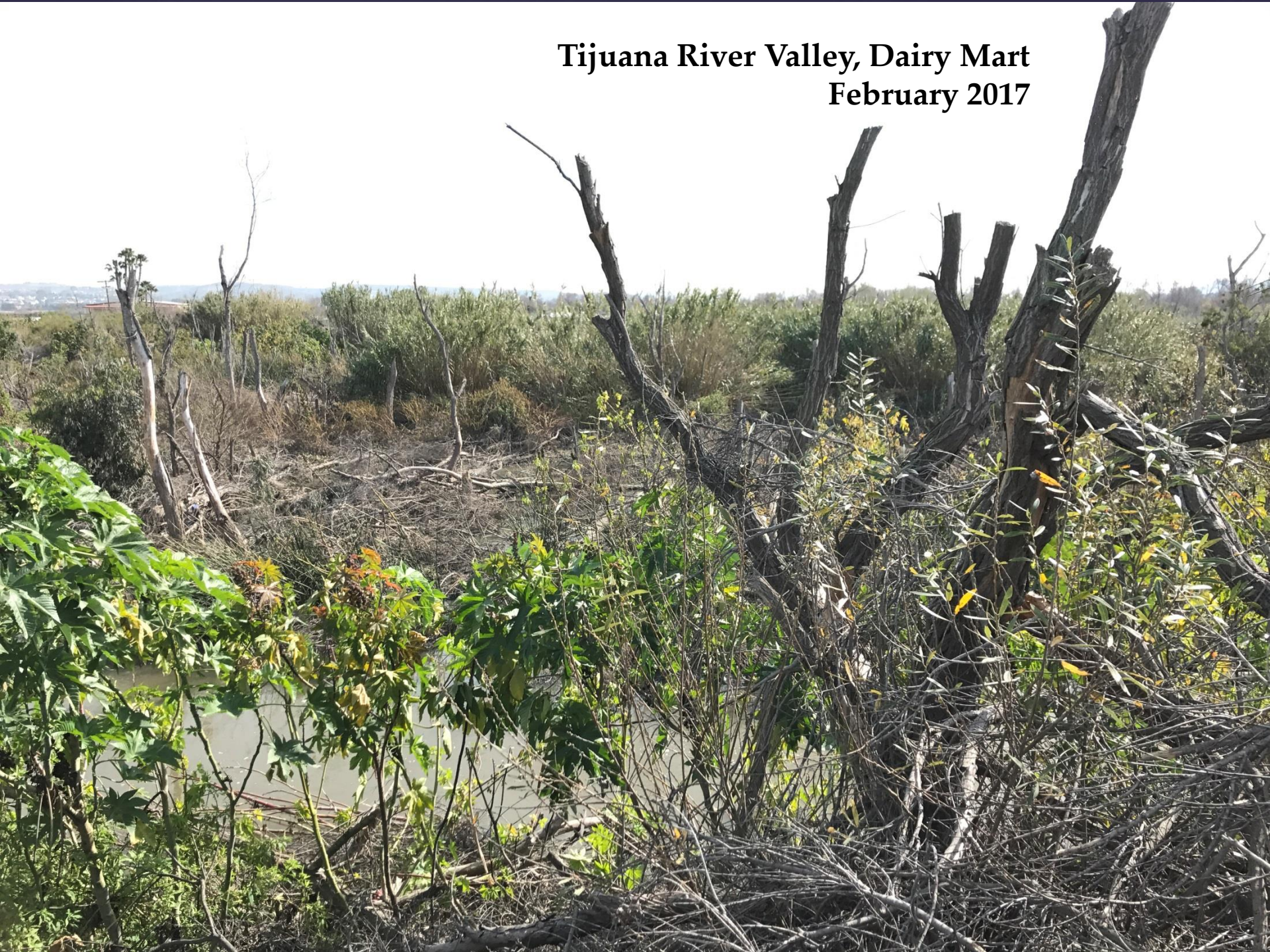
http://ucanr.maps.arcgis.com/apps/Viewer/index.html?appid=3446e311c5bd434eabae98937f085c80

Data Sources: University of California, Riverside; US Forest Service, Forest Health Protection; AG Comissioner Office Ventura and San Diego Counties; UCCE Los Angeles, Orange, Ventura, Santa Barbara, San Luis Obispo and San Diego Counties; and CalFire

Tijuana River Valley, Dairy Mart
May 2015

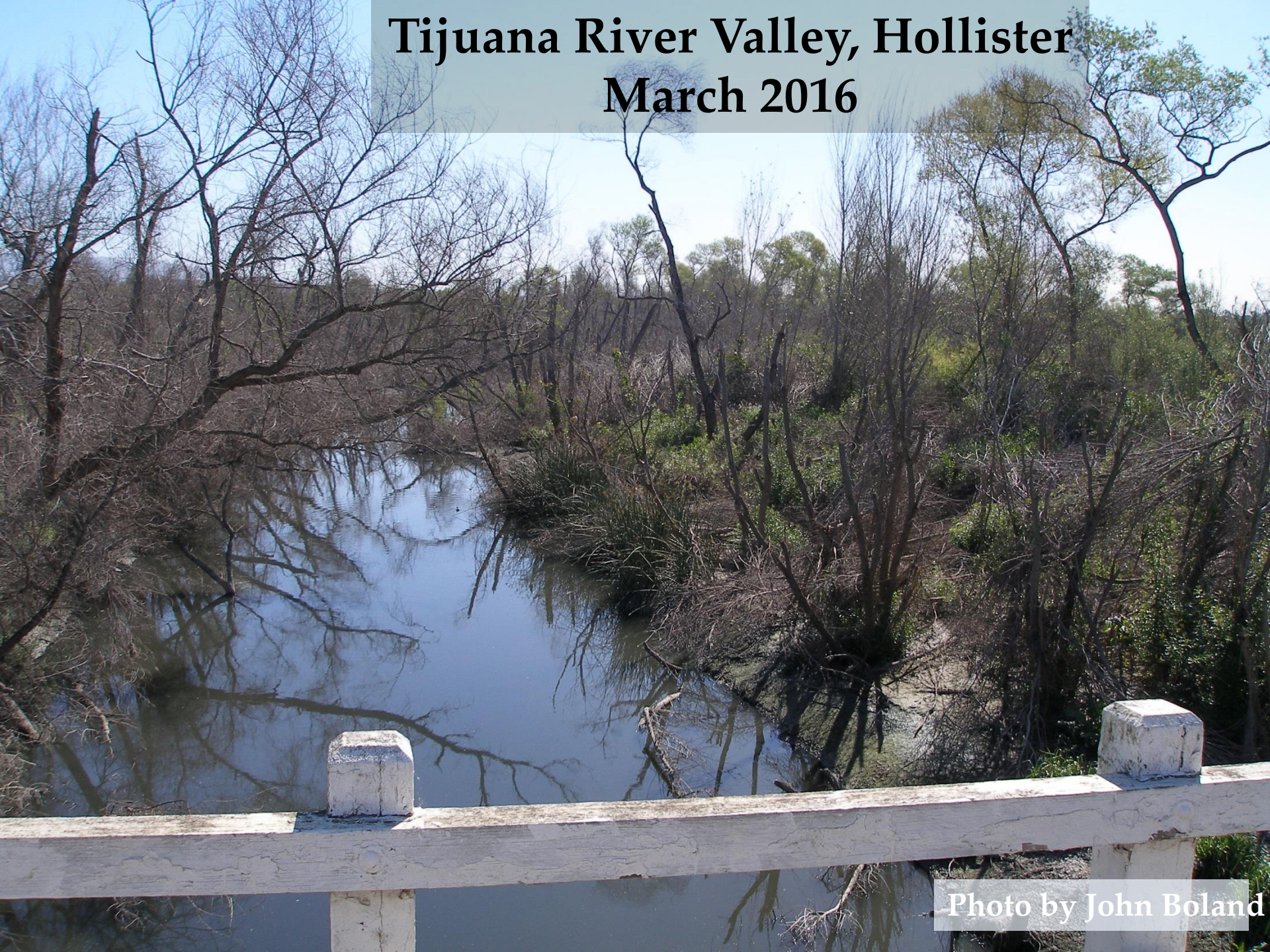



Tijuana River Valley, Dairy Mart
February 2016
Photo by John Boland



Tijuana River Valley, Dairy Mart
February 2017


Tijuana River Valley,
Hollister
April 2013
Photo by John Boland


Tijuana River Valley, Hollister
March 2016
Photo by John Boland

More Examples

Robertson Ranch, Carlsbad

San Luis Rey River, Oceanside

Confirmed Reproductive Host Tree List (PSHB)

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. Castorbean (*Ricinus communis*)
7. **California Sycamore (*Platanus racemosa*)***
8. Mexican sycamore *(Platanus mexicana)*
9. **Red willow (*Salix laevigata*)***
10. **Arroyo willow *(Salix lasolepis)****
11. Avocado (*Persea americana*)
12. Mimosa (*Albizia julibrissin*)
13. English oak (*Quercus robur*)
14. **Coast live oak (*Quercus agrifolia*)***
15. London plane (*Platanus* x *acerifolia*)
16. **Cottonwood (*Populus fremontii*)***
17. **Black cottonwood (*Populus trichocarpa*)***
18. **White alder (*Alnus rhombifolia*)***
19. Titoki (*Alectryon excelsus*)
20. **Engelmann oak (*Quercus engelmannii*)***
21. Cork oak (*Quercus suber*)
22. **Valley oak (*Quercus lobata*)***
23. Coral tree (*Erythrina corallodendon*)
24. **Blue palo verde (*Parkinsonia floridum*)***
25. **Palo verde (*Parkinsonia aculeata*)***
26. Moreton bay chestnut (*Castanospermum australe*)
27. Brea (*Cercidium sonorae*)
28. **Mesquite (*Prosopis articulata*)***
29. Weeping willow (*Salix babylonica*)
30. Chinese holly *(Ilex cornuta*)
31. Camelia (*Camellia semiserrata*)
32. Acacia (*Acacia* spp.)
33. Liquidambar (*Liquidambar styraciflua*)
34. Red flowering gum (*Eucalyptus ficifolia*)
35. Japanese wisteria (*Wisteria floribunda*)
36. **Goodding's black willow (*Salix gooddingii*)***
37. Tree of heaven (*Ailanthus altissima*)
38. Kurrajong (*Brachychiton populneus*)
39. Black mission fig (*Ficus carica*)
40. Japanese beech (*Fagus crenata*)
41. Dense logwood (*Xylosma congestum*)
42. **Mule fat (*Baccharis salicifolia*)***
43. **Black poplar (*Populus nigra*)***
44. Carrotwood (*Cupaniopsis anacardioides*)
45. **California buckeye (*Aesculus californica*)***
46. **Canyon live oak (*Quercus chrysolepis*)***
47. Kentia Palm (*Howea forsteriana*)
48. King Palm (*Ptychosperma elegans*)

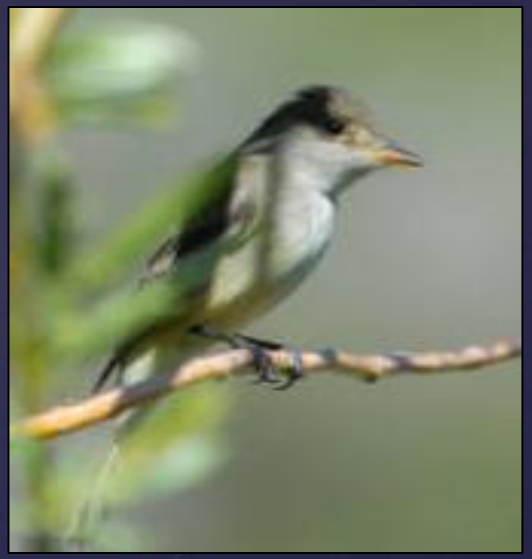
List Source: http://eskalenlab.ucr.edu/pshb.html accessed November 16, 2016

CDFW Photo Gail Sevrens

- **Known Suitable Reproductive Host Trees of Kuroshio shot hole borer in California**

- 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 Polar (Populus nigra)
- 7. Black locust (Robinia pseudoacacia)
- 8. Red Willow (Salix laevigata)*
- 9. Arroyo willow (Salix lasolepis)*
- 10. Cottonwood (Populus fremontii)*
- 11. Mimosa (Albizia julibrizin)
- 12. Castorbean (Ricinus communis)
- 13. Black Willow (Salix nigra)*
- 14. Strawberry Snowball Tree (Dombeya cacuminum)
- 15. Mule Fat (Baccharis salicifolia)*
- *Native tree species to California

SHBs impact riparian vegetation that supports least Bell's vireo, yellow-billed cuckoo, Southwest willow flycatcher, arroyo toad and Santa Ana sucker and/or their designated critical habitats.



Recovery of these species could be significantly impeded if control strategies are not implemented for this newly identified threat.

Monitoring Efforts

1. Visual Surveys

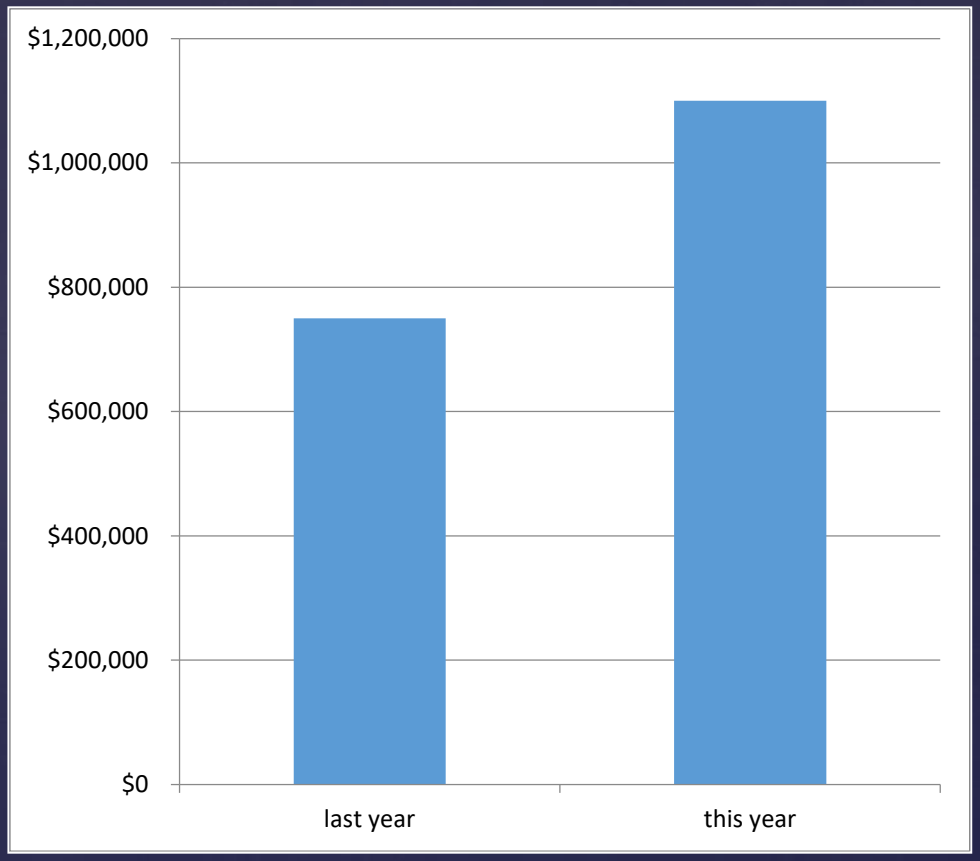
2. Trapping – Sticky traps, bottle traps, or
3. Lingrens trap with lure

Signs of Infection

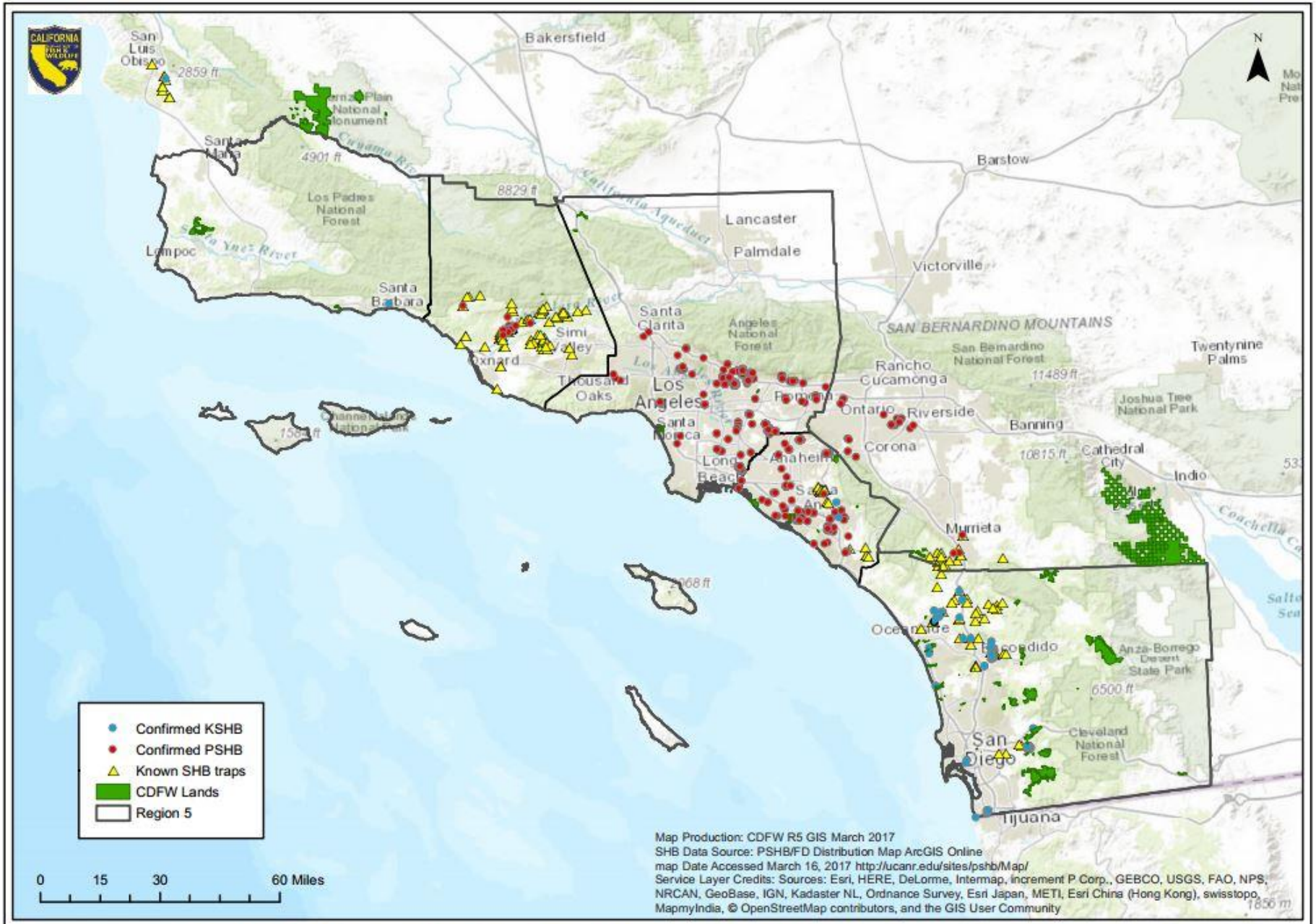
- Symptoms Vary by Tree Host Species

Look for branches . . .

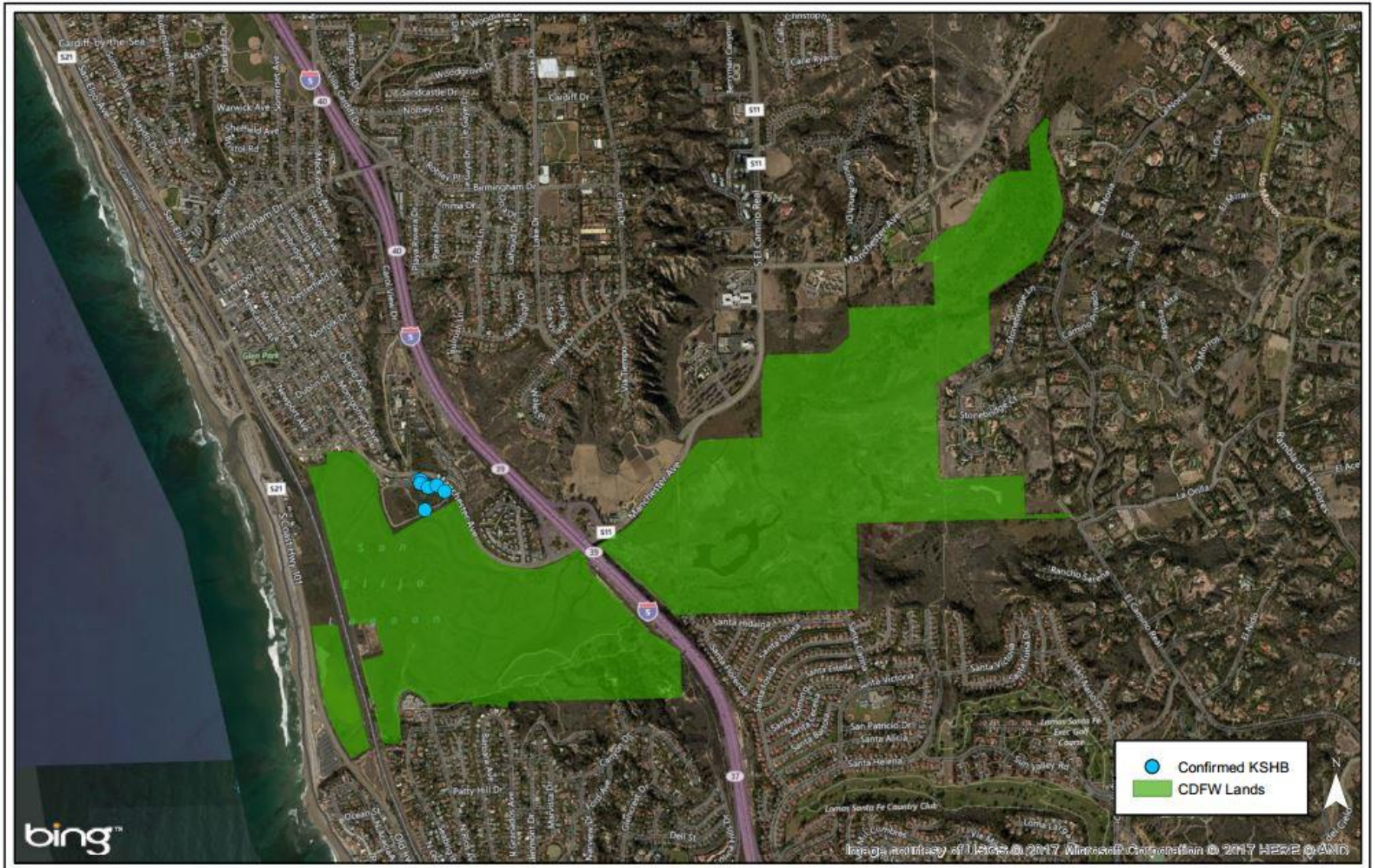
Orange County Parks – SHB Expenditures



Source: Bill Kirk, OC Parks



California Department of Fish and Wildlife Properties and Shot Hole Borer Confirmed Locations Overview

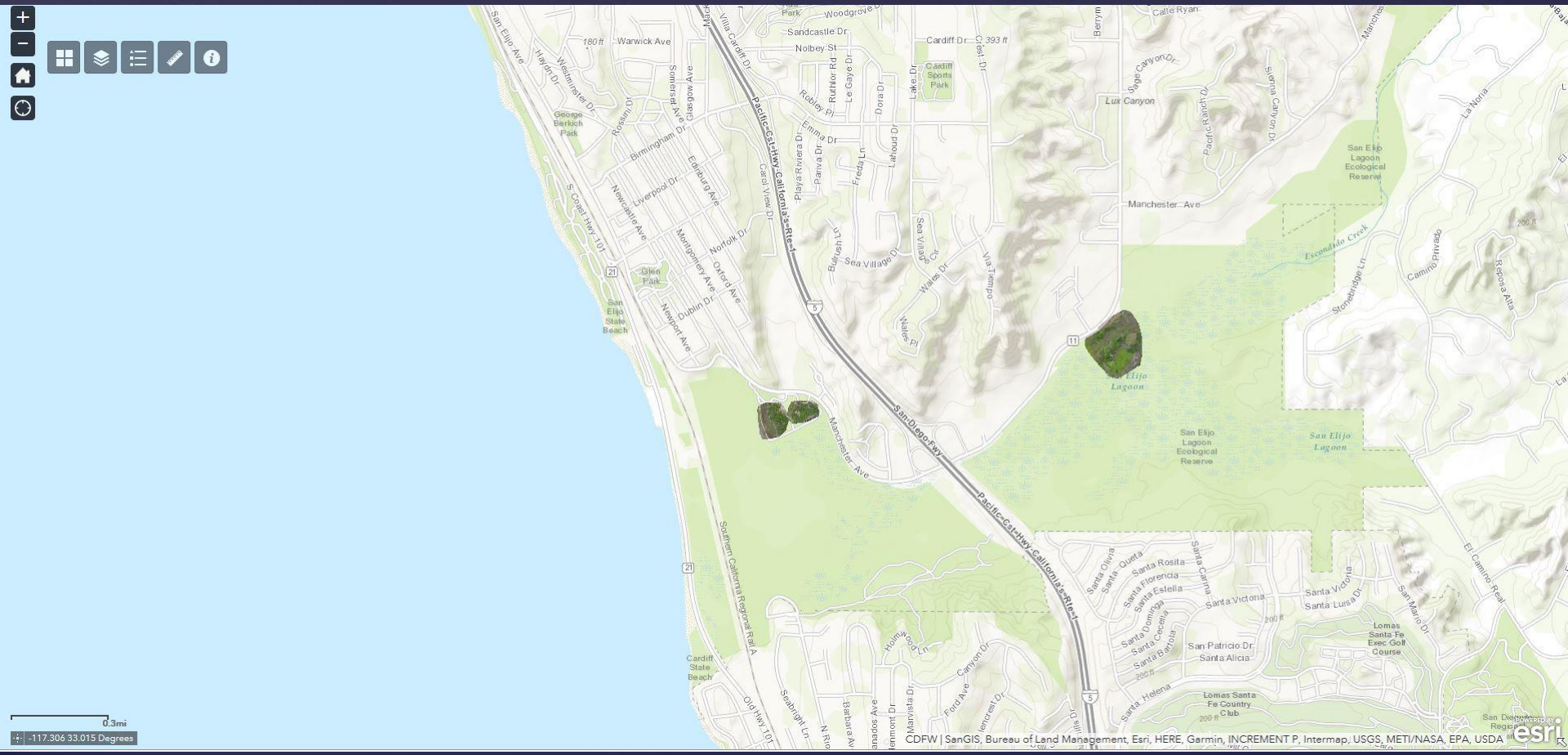


San Elijo Ecological Reserve and Shot Hole Borer Confirmed Locations

Aproximate confirmed distance to
San Elijo Ecological Reserve: < .1 mile

0 0.25 0.5 1 Mile

Map Production: CDFW R5 GIS March 2017
SHB location data: PSHB/FD Distribution Map ArcGIS Online map
Date Accessed March 16, 2017 http://ucanr.edu/sites/pshb/Map/


Warwick Ave
Sandcastle Dr
Nolbey St
Cardiff Dr
393 ft
Cardiff Sports Park
Lux Canyon
Manchester Ave
Pacific Coast Hwy California's Rte 1
San Diego Fwy
Glen Park
San Elijo State Beach
Cardiff State Beach
San Elijo Lagoon Ecological Reserve
Escondido Creek
Lomas Santa Fe Exec Golf Course
Lomas Santa Fe Country Club
Santa Victoria
Santa Alicia
Santa Helena
Southern California Regional Rail A
0.3mi
-117.306 33.015 Degrees
CDFW | SanGIS, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, EPA, USDA
esri

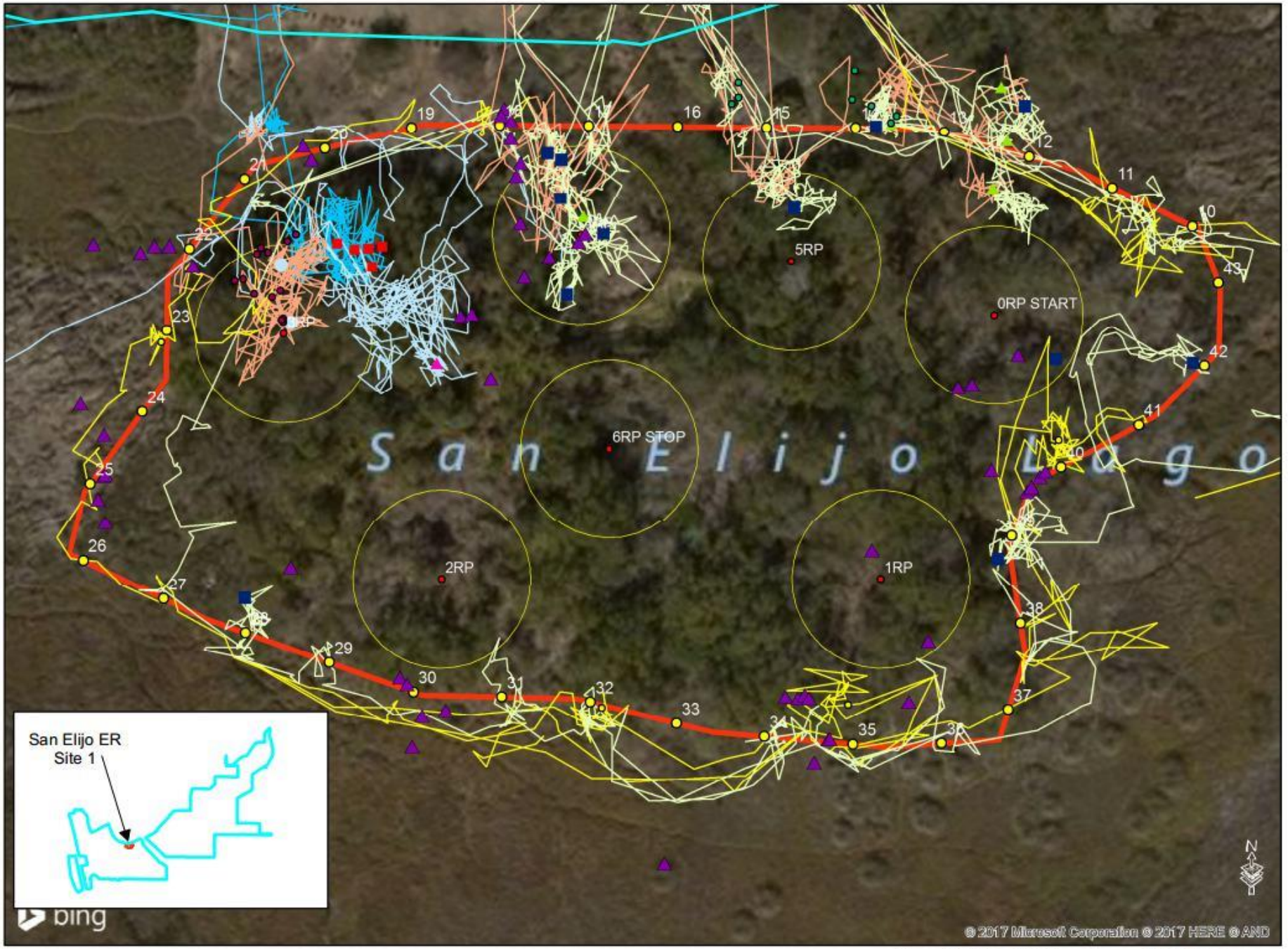

MIRA COSTA COLLEGE RD
MANCHESTER AVE
S11
S11
3289
3289
3121
30 ft
San Elijo Lagoon
CDFW | SanGIS, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, EPA, USD


-117.257 33.016 Degrees
CDFW | SanGIS, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, EPA, USDA
POWERED BY esri


256 33.016 Degrees
CDFW | SanGIS, Bureau of Land Management, Esri, HERE, Ga

San Elijo ER Site 1

0 0.005 0.01 0.02 Miles



San Elijo ER Site 1 - survey tracks, waypoints and photo sites

Treatment and Research

UC Riverside, UC ANR CE, and others

Treatment:

- Mechanical – cut, chip, solarize
- Chemical – research on efficacy of chemicals still underway.
- Bio-control – still underway
- DO NOT transport infected wood offsite
- Treat early if possible

CDFW Photo by Gail Sevrens

Professor Akif Eskalon shows impacted wood to land managers and regulators.

Treatment and Research

UC Riverside, UC ANR CE, SWIA and others

<u>Researching:</u>

- Natural enemies—parasitoid wasp;
- Endophytes—bacteria & fungus that live between living plant cells, analogy: like your natural gut bacteria;
- Entomopathogenic fungi;
- Resprouting

Tijuana River Valley, May 2016, CDFW Photo by Gail Sevrens

Photo by John Boland

Shot Hole Borers/Fusarium Dieback Management Strategy

- Initiated by San Diego Association of Governments to solicit input for overarching strategy

- Includes actions, with rationales, implementation, and measurable objectives:
  1. Leadership & Governance
  2. Surveying
  3. Management Options–Short Term
  4. Public Outreach
  5. Research Leading to Long-Term Management
  6. Implementation Timelines
  7. Seeking and Directing Funding

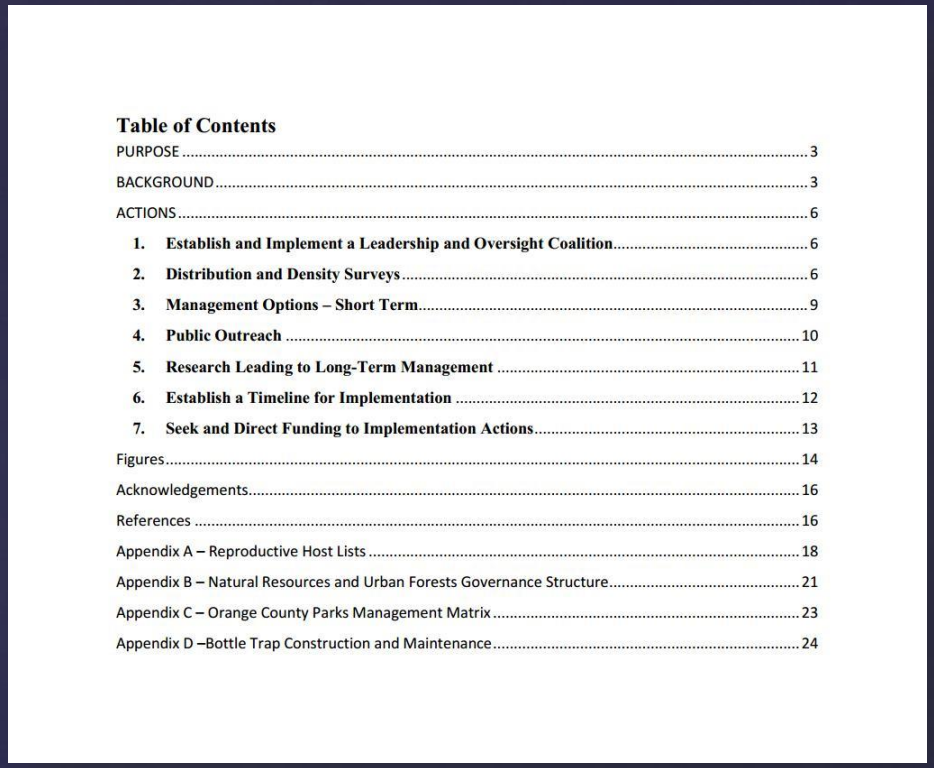
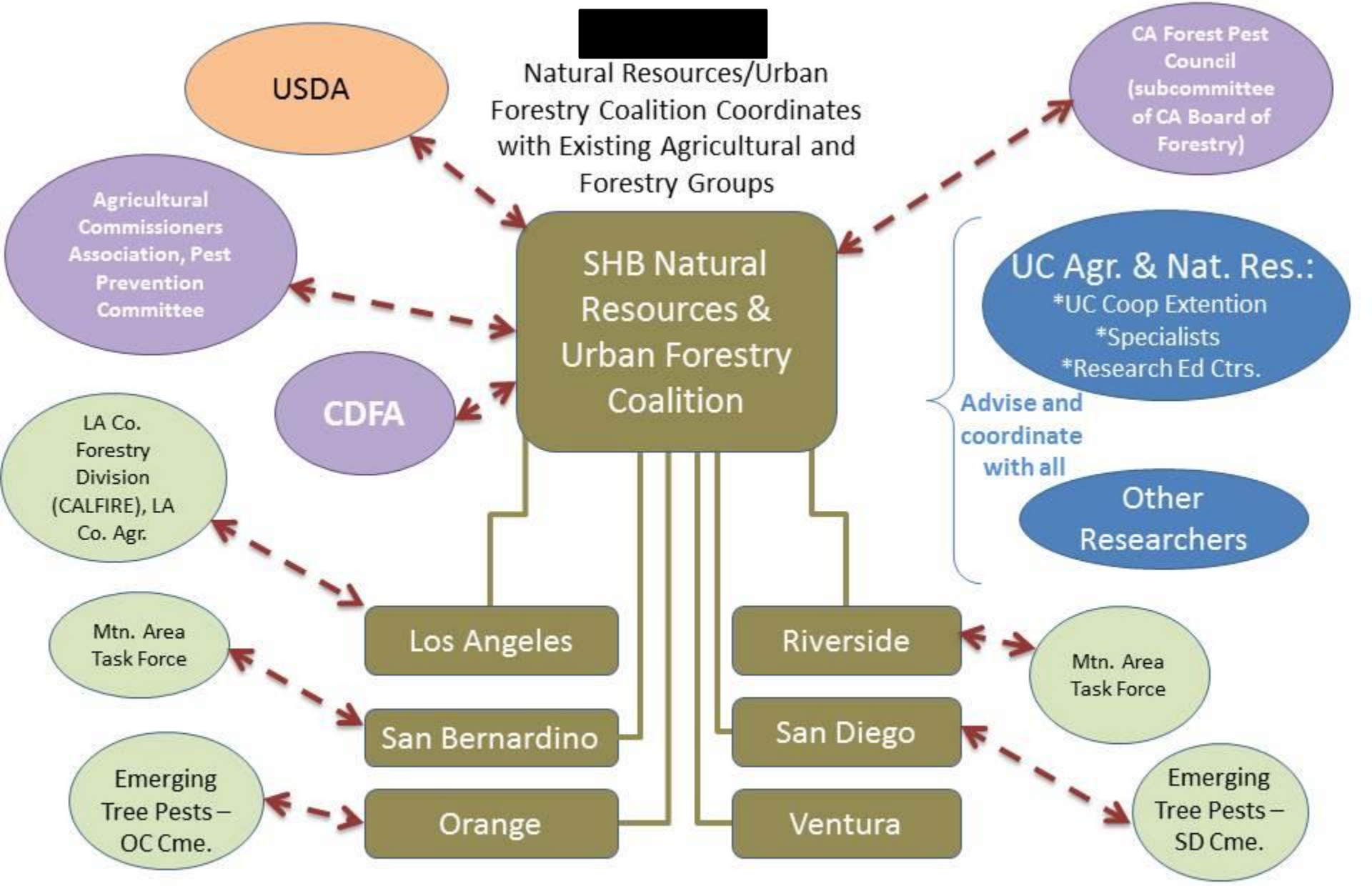


Table of Contents

SANDAG

Who is Working on Solutions in the Natural Resources Environment?

- Emerging Pest Working Group
- Natural Resources/Urban Forestry SHB Coalition
- Polyphagous Shot Hole/Invasive Borer Statewide Plan
- UC Riverside, UC Santa Cruz, UC ANR, UCI
- Regulatory Agencies (USFWS, CDFW, USACOE, USDA)
- Local and Municipal Groups (SANDAG, OC Parks, San Diego County, others)
- California Forest Pest Council
- Many others – next slide


[redacted]
Natural Resources/Urban Forestry Coalition Coordinates with Existing Agricultural and Forestry Groups
USDA
CA Forest Pest Council (subcommittee of CA Board of Forestry)
Agricultural Commissioners Association, Pest Prevention Committee
SHB Natural Resources & Urban Forestry Coalition
UC Agr. & Nat. Res.:
*UC Coop Extention
*Specialists
*Research Ed Ctrs.
CDFA
Advise and coordinate with all
Other Researchers
LA Co. Forestry Division (CALFIRE), LA Co. Agr.
Mtn. Area Task Force
Los Angeles
Riverside
Mtn. Area Task Force
San Bernardino
San Diego
Emerging Tree Pests – OC Cme.
Orange
Ventura
Emerging Tree Pests – SD Cme.
= natural areas & urban focus
= forestry and/or agr. focus
= internal coordination
= external coordination
Blue=academic
Peach = federal
Green=local
Purple=statewide
Brown=us

8/26/2016

Coordination

- Numerous groups are focusing on forestry and agricultural issues.
- Universities are undertaking research.
- New coalition to address natural resource/urban forestry issues. Is following the outline of the SANDAG-spearheaded strategic plan. Monthly coordination calls; two thus far; first call had >50 participants. Three subcommittees have been launched. Goal is to not duplicate existing efforts. Contact Gail.Sevrens@wildife.ca.gov to be added to notification list.

Future Action

- Participate in coordination efforts.
- Surveying and management.
- Support research efforts.
- Assist with seeking funding.
- Be prepared to share information with agencies, legislators, stakeholders, public.

Further resources: www.PSHB.org

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t Explorer

University of California, Agriculture and Natural Resources

Invasive Shot Hole Borers

Home | Pest Overview | Distribution Map | Diagnosis and Management | Resources | Monitoring and Research | News and Events | Contacts

What are the Polyphagous and Kuroshio Shot Hole Borers?

The Polyphagous Shot Hole Borer (PSHB) is an invasive wood-boring beetle that attacks dozens of tree species in Southern California, including commercial avocado groves, common landscape trees, and native species in urban and wildland environments.

PSHB spreads a disease called Fusarium Dieback (FD), which is caused by pathogenic fungi. Trees

Upcoming Events

Event Name	Date
Now Hiring: Emerging Tree Pest Educ. Specialist	7/8/2016
Invasive Tree Pests Issues-San Diego	7/28/2016

Acknowledgements:

Jeff Brandt and Claire Ingel, CDFW – Region 6
David Zoutendyk, Eric Porter, and Patrick Gower, US Fish and Wildlife Service
Christine Sloan-Tolchin, County of San Diego
Yvonne Moore and Kris Preston, San Diego Monitoring and Management Program
Shanti Santulli, US Army Corps of Engineers
Jim Sulentich, Natural Communities Coalition (formerly NROC)
Kevin Turner and ETPSC of San Diego
Akif Eskalen and Richard Stouthamer, UC Riverside
Jan Gonzalez and John Kabashima, UC Agriculture and Natural Resources Cooperative Extension
John Boland, Southwest Wetlands Interpretive Association
Keith Greer and Kyle Rice, San Diego Association of Governments
Megan Lulow, UCI
CDFW staff – Gail Severen, Marilyn Fluharty, Tim Dillingham, Marcus Hubbell, Ken Devore, Amanda Eigner, Aidan Renner, Ryan Lawler, Joel Trumbo, John Ekhoff, Tracie Nelson, Jason Price, Gabriel Penaflor, Will Patterson, Steve Goldman

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Mahalo!!