The influence of invasive species on fuel loading in native forest stands in southern California

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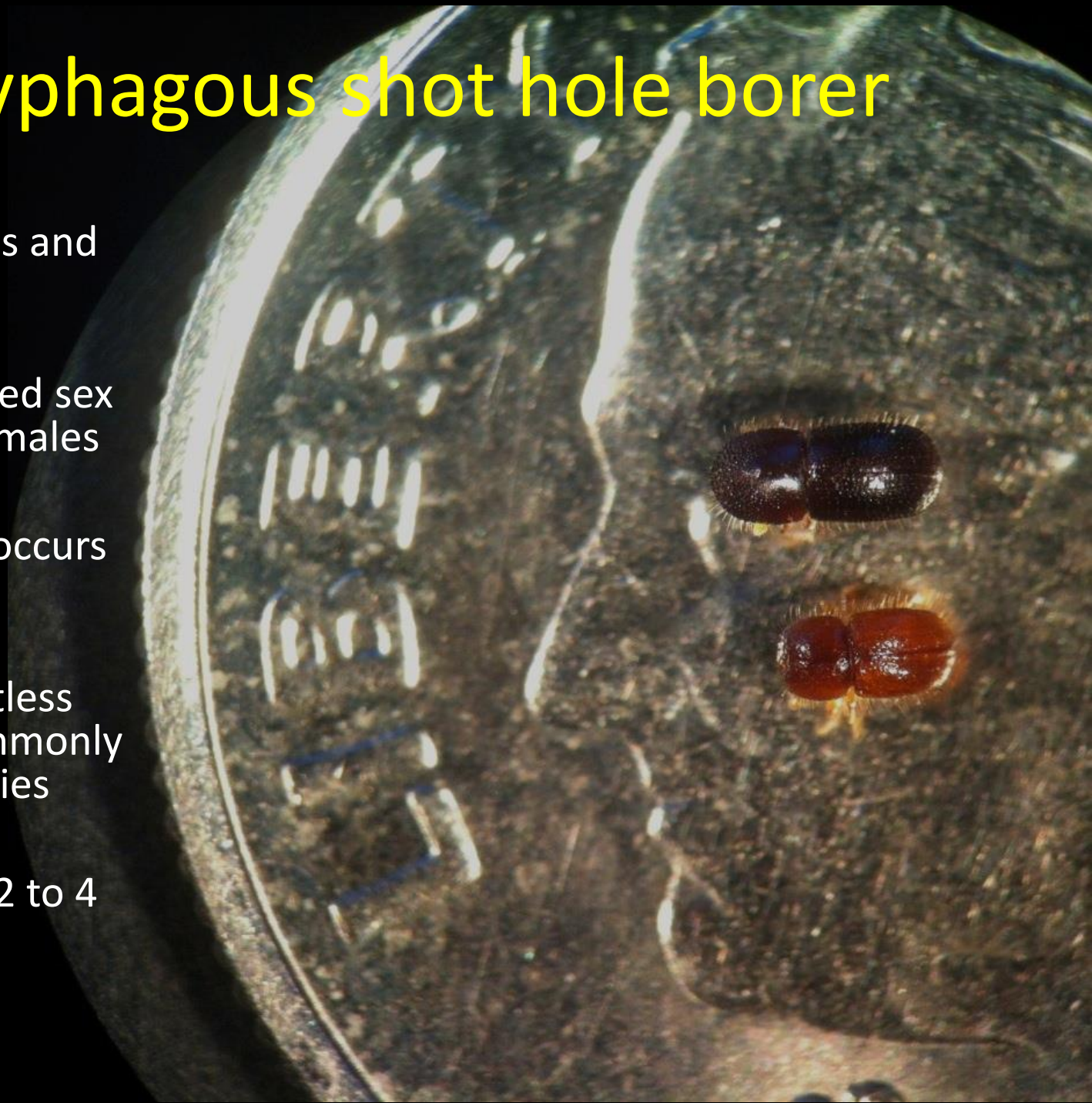
Polyphagous shot hole borer (PSHB), *Euwallacea* sp.

- First detected in California in 2003
  - Insect/disease complex not linked to tree injury and mortality until 2012 in LA County
- PSHB was initially believed to be the tea shot hole borer, *Euwallacea fornicatus*
  - Recent DNA work suggests PSHB may be a new species and this same species is found in Israel
  - Our PSHB population may be from Vietnam

Polyphagous shot hole borer

- Feeds on fungus and not the wood
- There is a skewed sex ratio toward females
- Sibling mating occurs in the galleries
- Males are flightless and do not commonly leave the galleries
- May complete 2 to 4 generations/yr



Insect/Disease complex: PSHB and Fusarium dieback

- PSHB carries several fungi
  - *Fusarium euwallaceae* (new species)
  - *Graphium* sp.
  - *Sarocladium* sp.
  - Eskalen is conducting pathogenicity tests with each fungus

PSHB known host species

In southern California:

- English oak *(Quescus robur)*

- Mimosa *(Albizia julibrissin)*
- Coral tree *(Erythrina corallodendon)*
- Blue palo verde *(Parkinsonia florida)*
- Palo verde *(Cercidium floridium)*
- Brea *(Cercidium sonorae)*
- Black bean *(Castanospermum*

- Tortuosa *(Salix matsudana)*
- Weeping willow *(Salix babylonica)*
- *australe)*

- Camelia *(Camelia semiserrata)*

- Castor bean *(Ricinus communis)*

- Red Flowering Gum (*Eucalyptus ficifolia*)

- Avocado *(Persea americana)*

- Trident maple *(Acer buergerianum)*
- Japanese maple *(Acer palmatum)*
- Evergreen Maple *(Acer paxii)*
- Titoki *(Alectryon excelsus)*

- Chinese holly *(Ilex* cornuta*)*

- Coast live oak *(Quercus agrifolia)*
- Valley oak (*Quercus lobata*)

- American sweetgum *(Liquidambar styraciflua)*

- California Sycamore *(Platanus racemosa)*

- Big leaf maple *(Acer macrophyllum)*
- Box elder *(Acer negundo)*

- Red willow (*Salix laevigata*)

- White alder (*Alnus rhombifolia*)

PSHB injury symptoms

Current PSHB activities

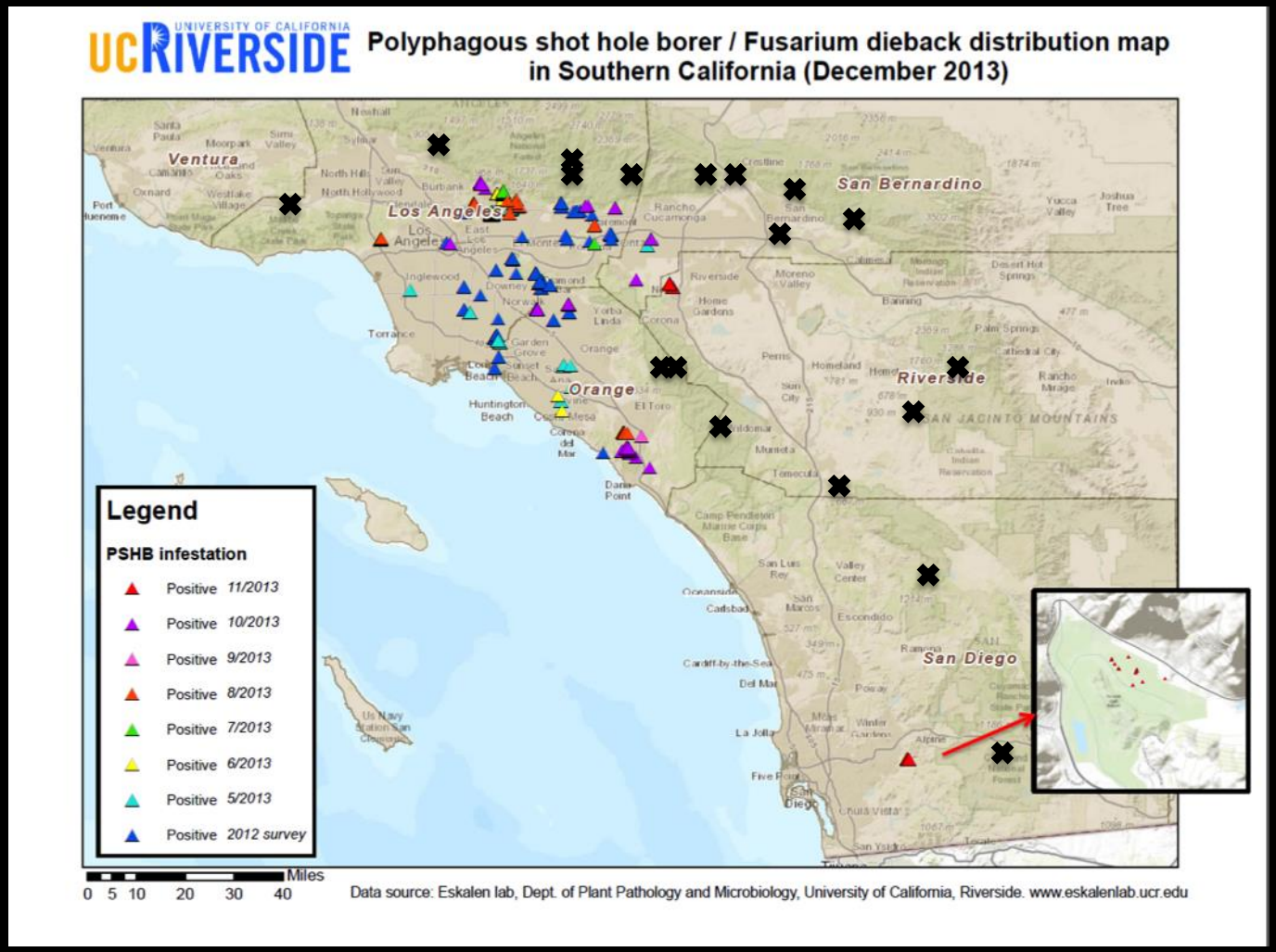
1. Delimit the distribution of the invasive pest complex on public and private land

2. Determine the PSHB life cycle

3. Develop monitoring tools and management options

4. Determine the impact of the pest complex in native hardwood stands and in urban forests (native species)

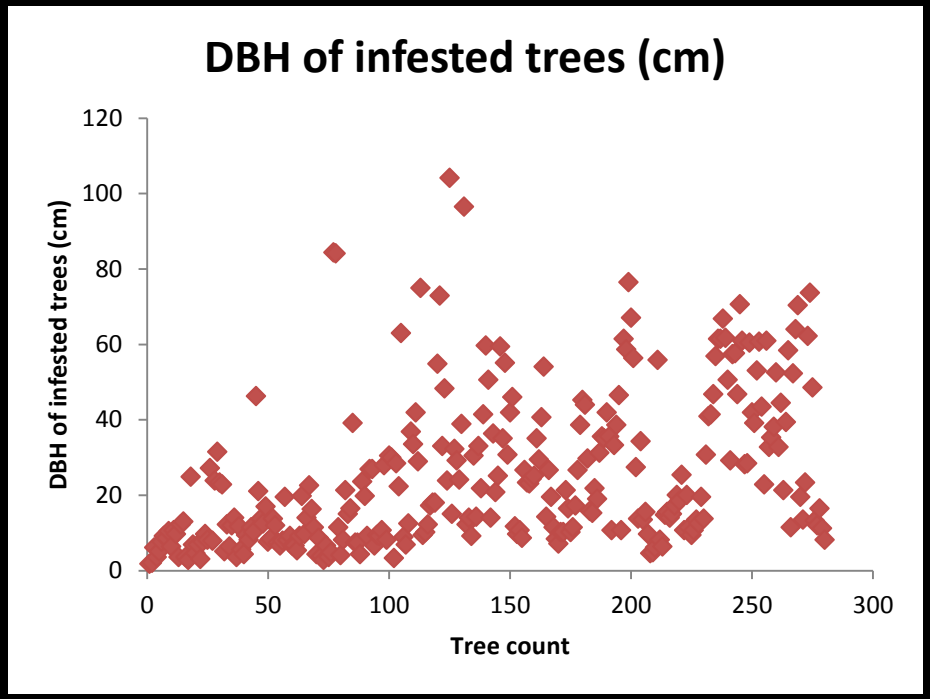
Current distribution of PSHB in CA

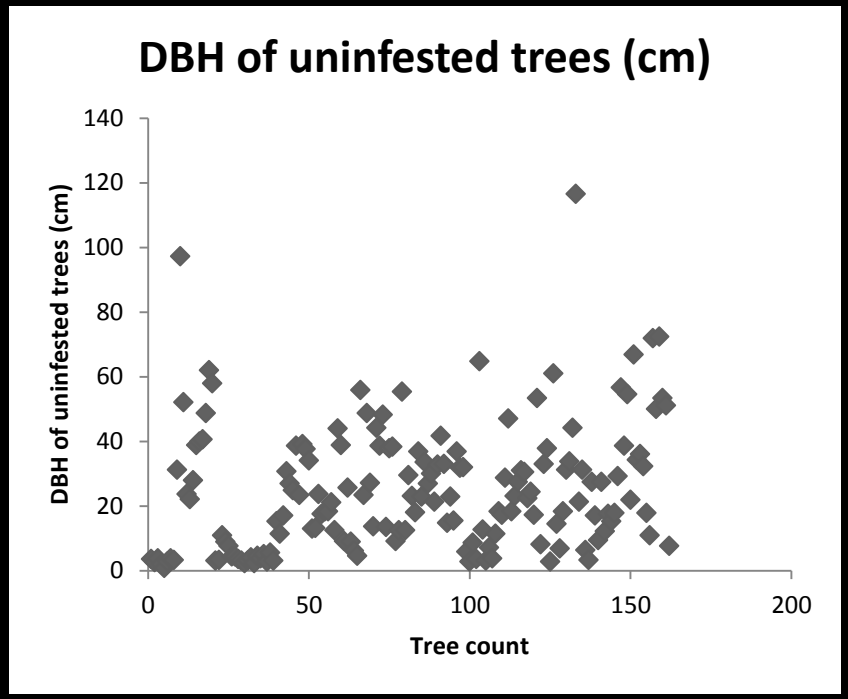


- Infested counties:
  - Los Angeles
  - Orange
  - Riverside
  - San Bernardino
  - San Diego

- El Cajon (San Diego Co.): Recent detection of PSHB

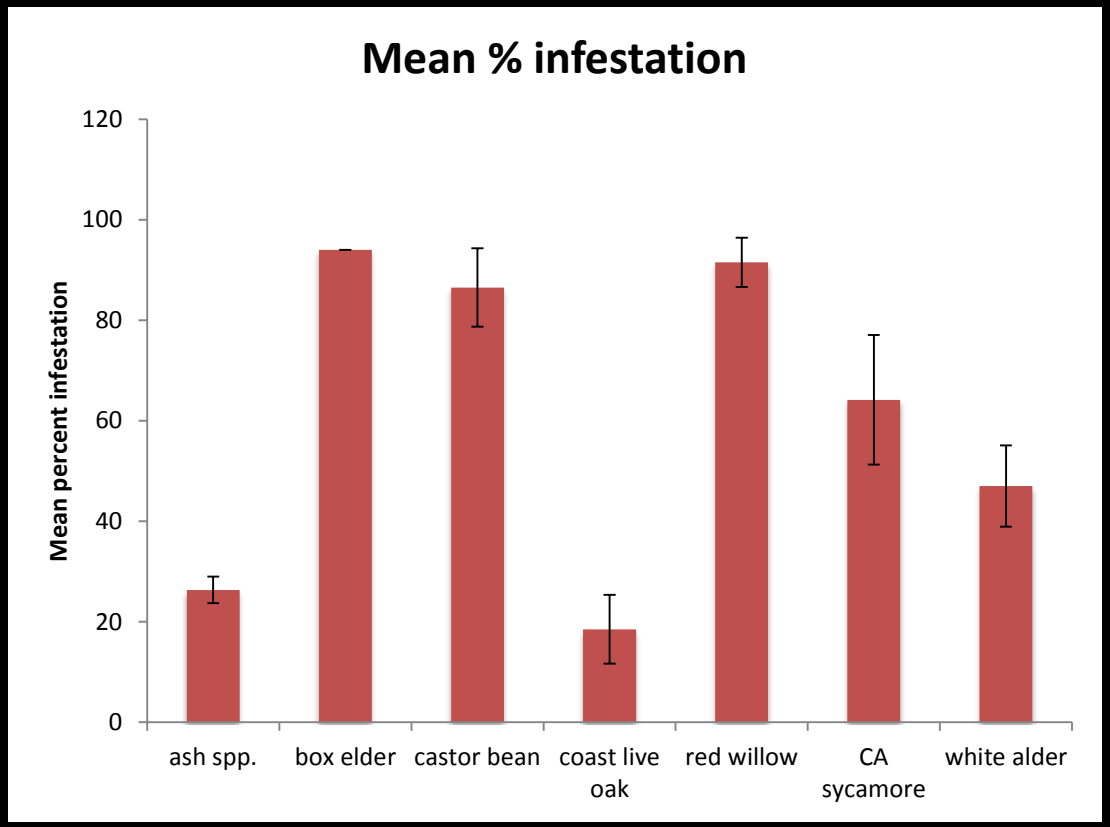
Preliminary survey data:





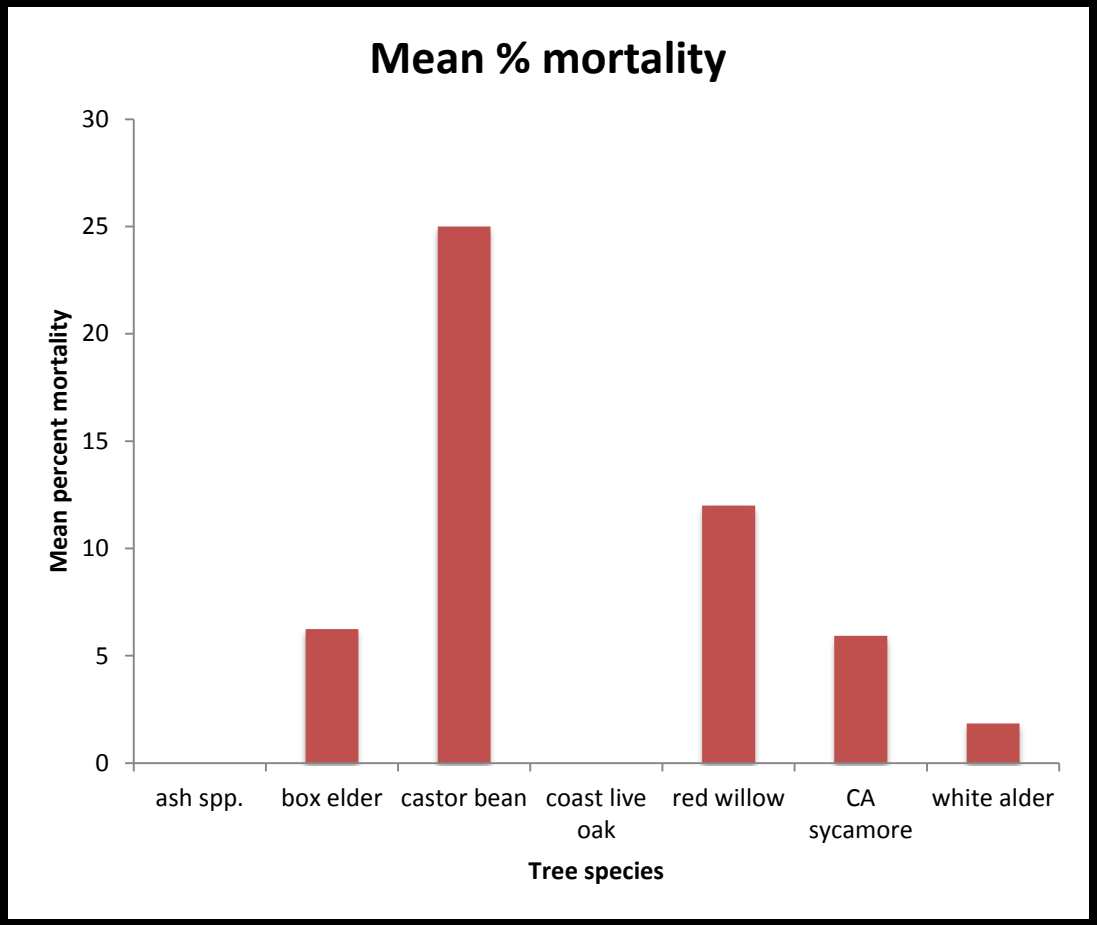
- PSHB attacks all size classes
  - DBH range of infested trees: 1.07 to 104 cm
- Attacks are more common along the main stem

Preliminary survey data:



- Six infested stands were surveyed on the Angeles NF and urban areas
  - 15 species total
  - 475 trees surveyed

Preliminary survey data:



- Currently, low levels of tree mortality are occurring across these infested stands
  - Tree mortality can take a few years

Tree injury/mortality associated with PSHB

- Observed tree mortality or severe tree injury
  1. Box elder
  2. Castor bean
  3. California sycamore
  4. Red willow
  5. White alder
  6. Avocado
  7. English oak
  8. coast live oak

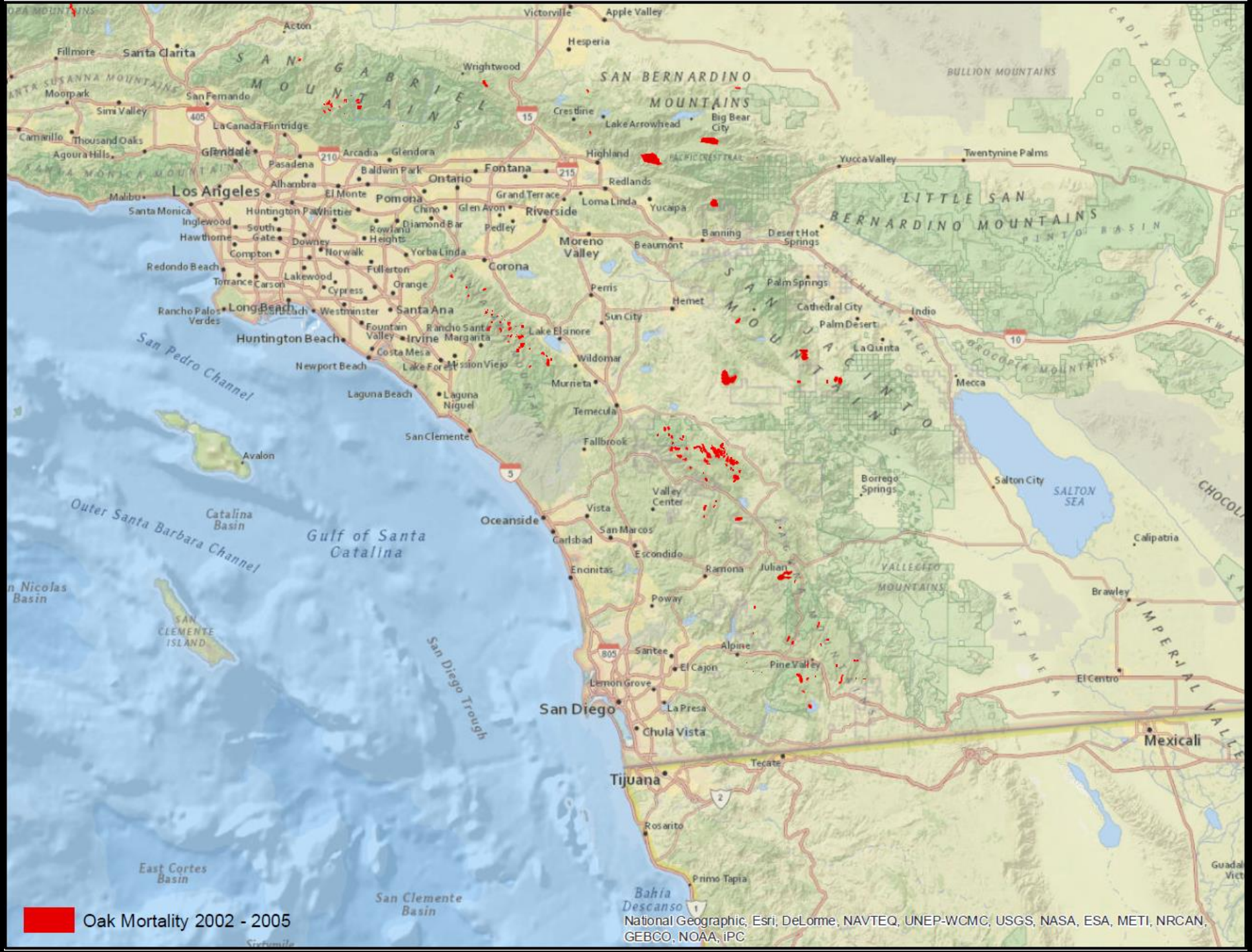
PSHB impacts

- PSHB is already impacting our native and urban forests
  - Wildland urban interface
- But, we still know very little about this insect-disease complex

Goldspotted oak borer (GSOB)
(*Agrilus auroguttatus*)

GSOB larval feeding

- Larval feeding girdles a tree's cambium
- Several years of repeated larval feeding are required to kill a tree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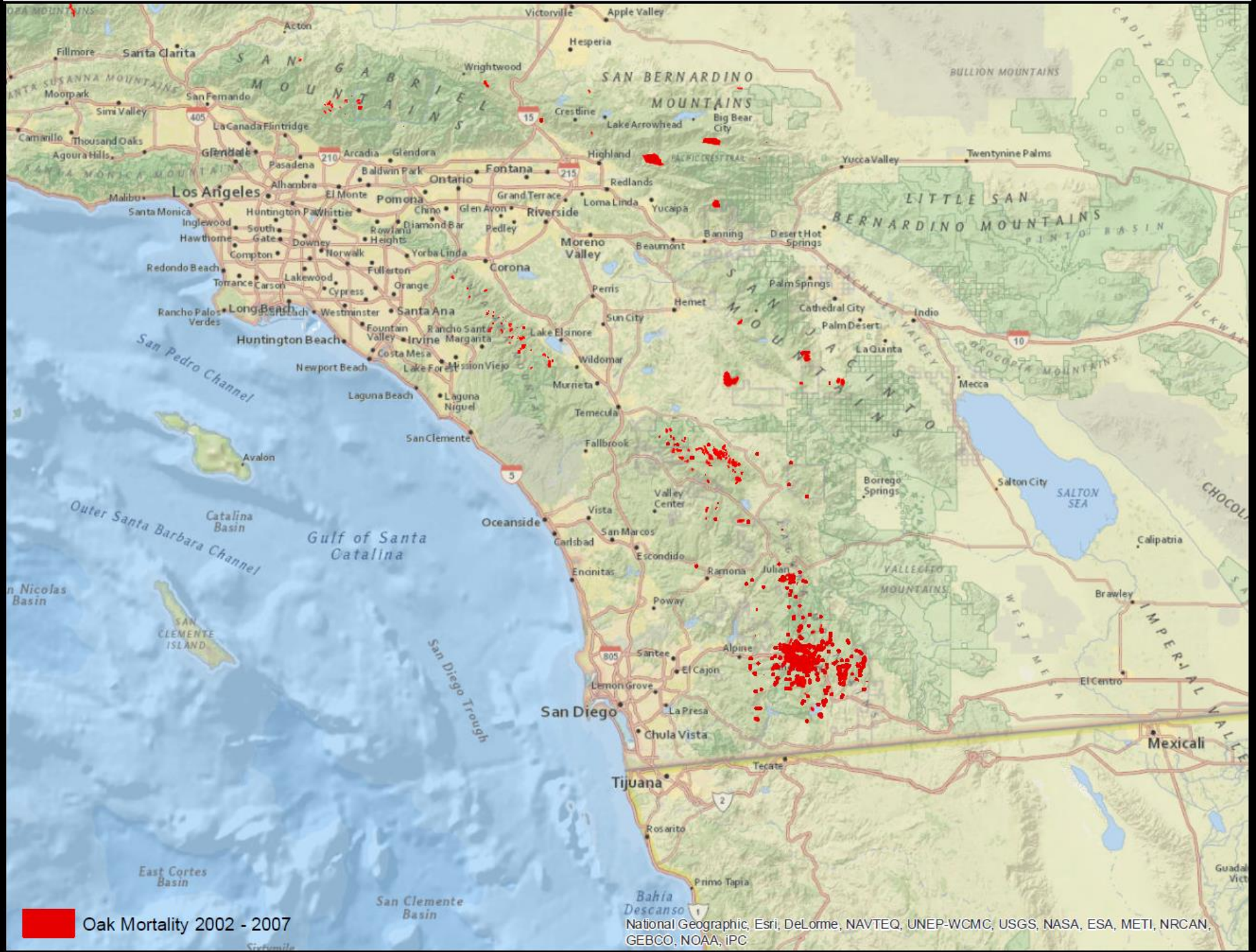
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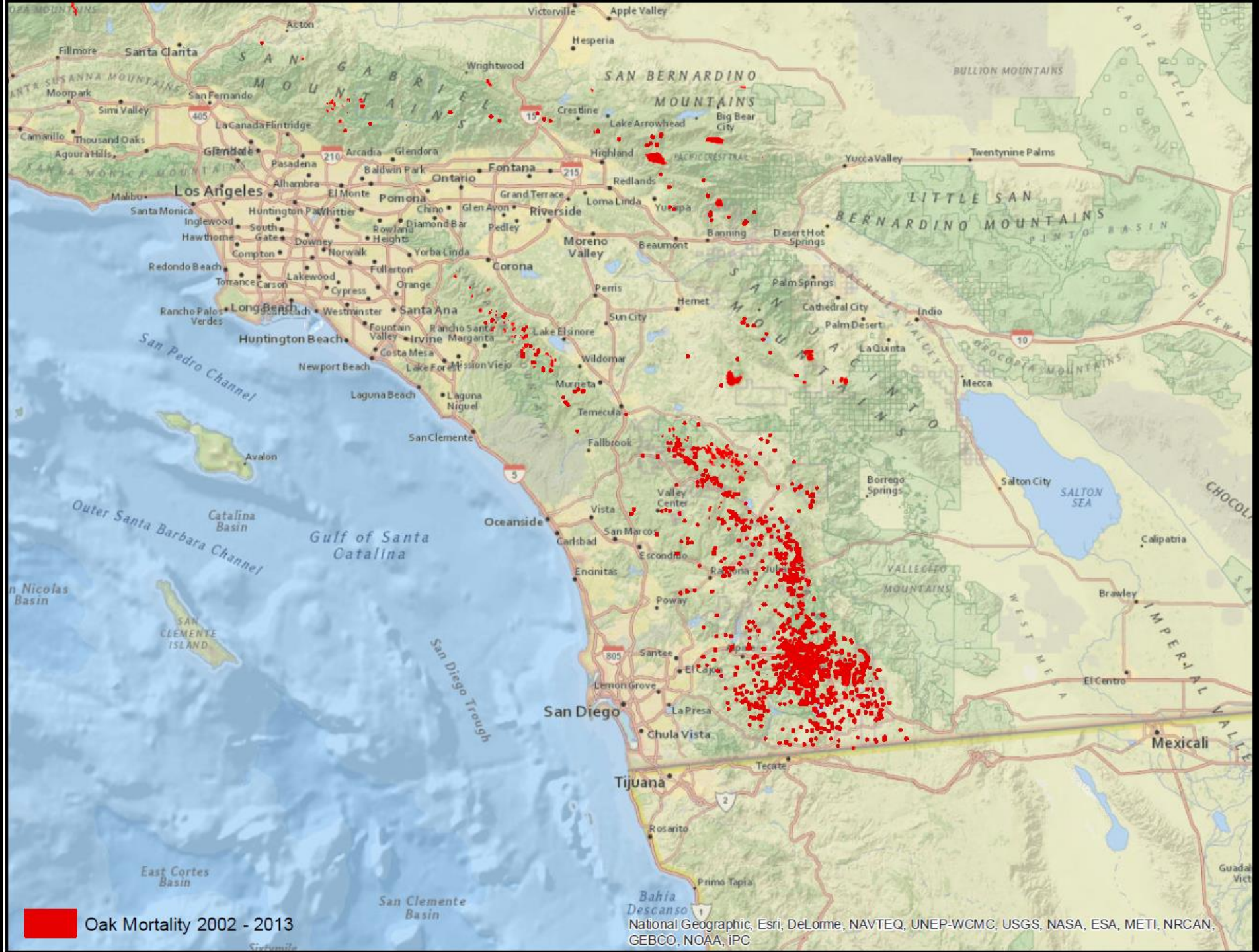
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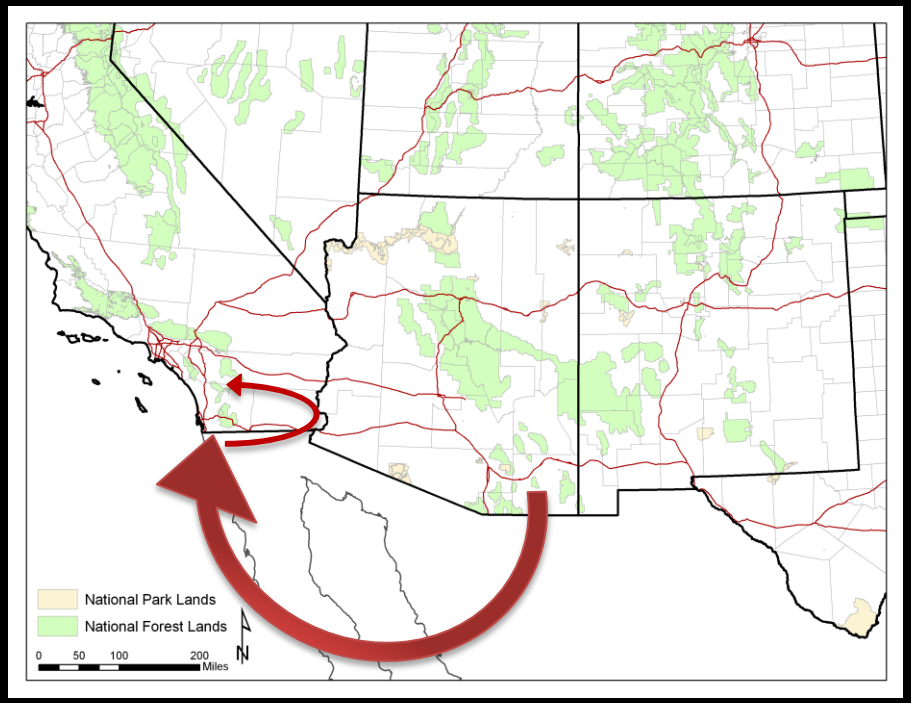
Source of CA's GSOB population



- CA population is most similar to populations in southeastern AZ
- Likely brought in on firewood

GSOB hosts: in CA

- Coast live oak

- California black oak

- Canyon live oak

- Engelmann oak

in AZ

- Emory oak

- Silverleaf oak

GSOB injury symptoms

GSOB exit holes

GSOB integrated pest management

- Developing an IPM program for high-value sites
- Collaborative work with UC Riverside, FS Research, UC Davis, and APHIS

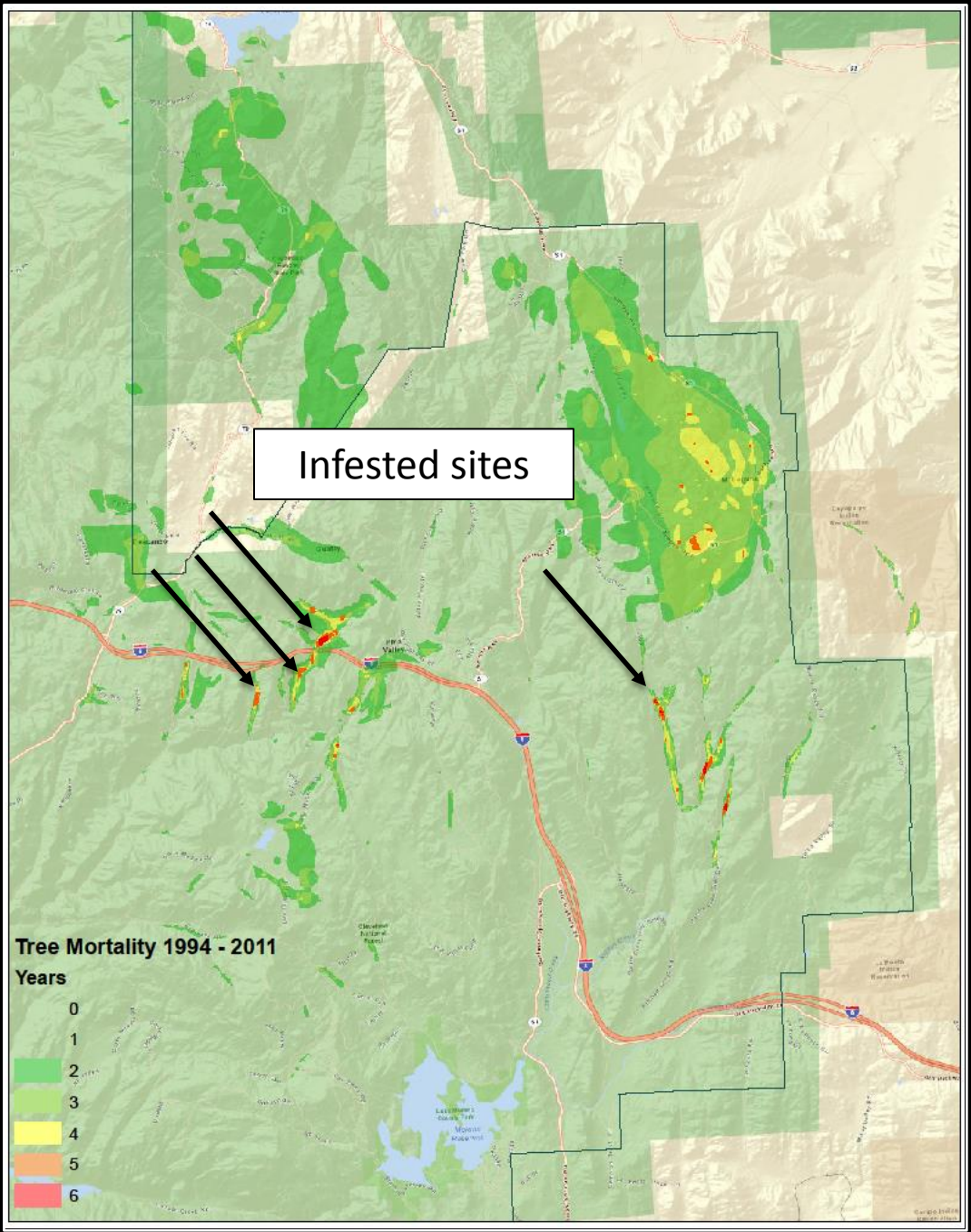
Secondary effects: Influence of GSOB on fuel structure

Uninfested

Infested (>10 yrs)

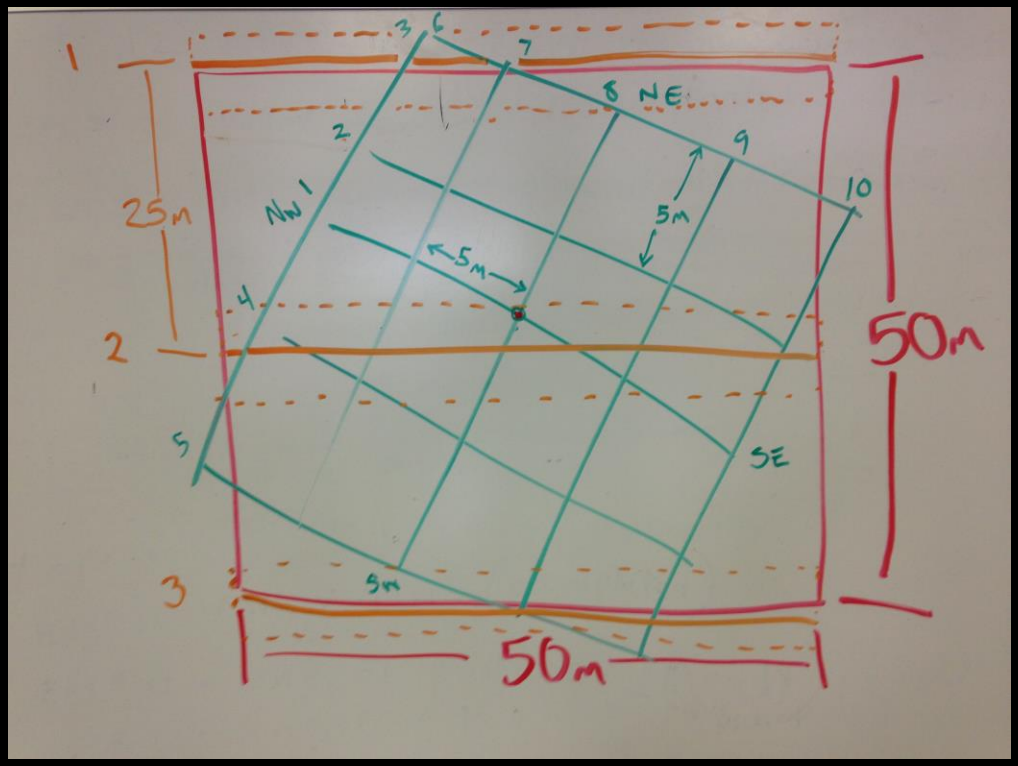
Stands severely impacted by GSOB

- Uninfested coast live oak stands
  - 5 sites in southern CA
- Infested sites
  - 4 sites on the Cleveland NF
  - >10 yrs with GSOB injury



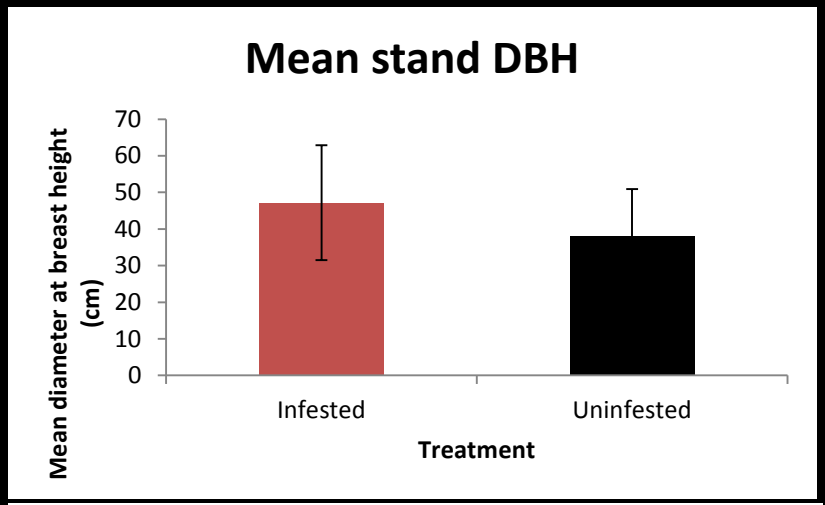
Study design

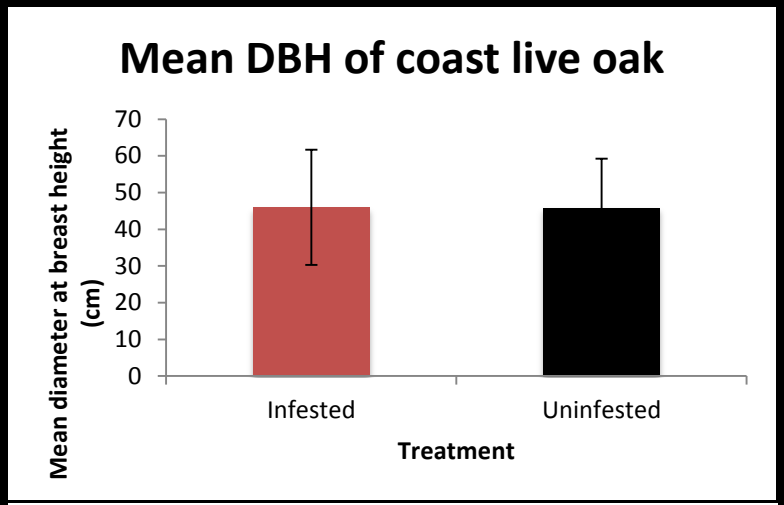
- Measured:
  - **Forest composition:** Trees (ha), basal area (ha), % infestation, % tree mortality, decay class, GSOB injury ranking
  - **Canopy fuels:** Canopy cover, tree height, base crown height,
  - **Understory fuels:** Oak regeneration, regeneration height
  - **Surface fuels:** 1-, 10-, 100-, 1000-h fuels, % ground cover, leaf litter depth

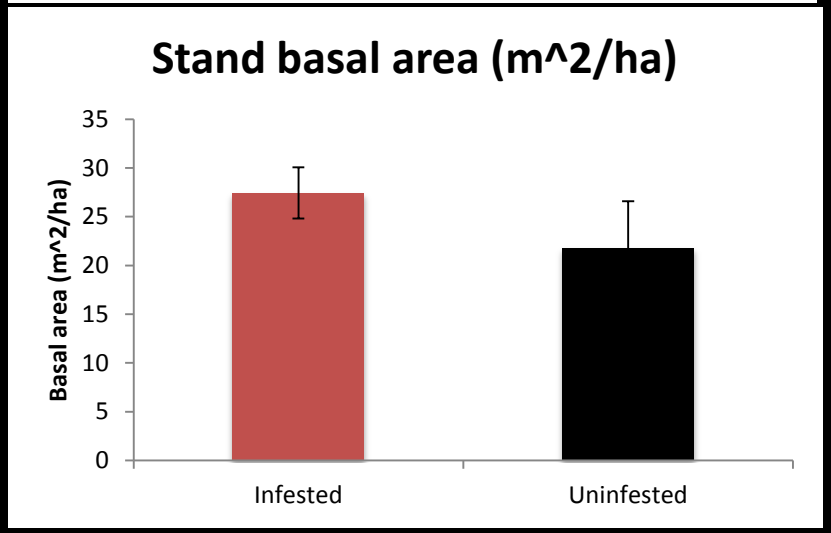


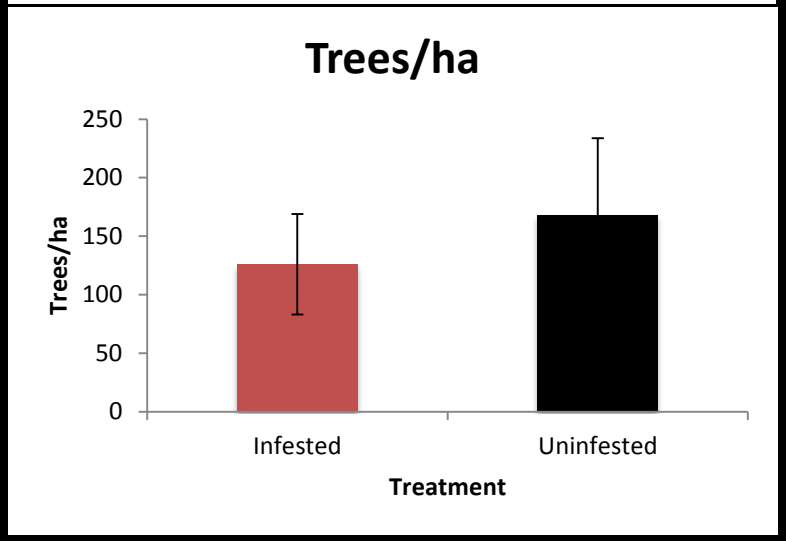
- 0.25 ha plot
- Three belt transects
- Brown's transects

Preliminary data: Forest composition



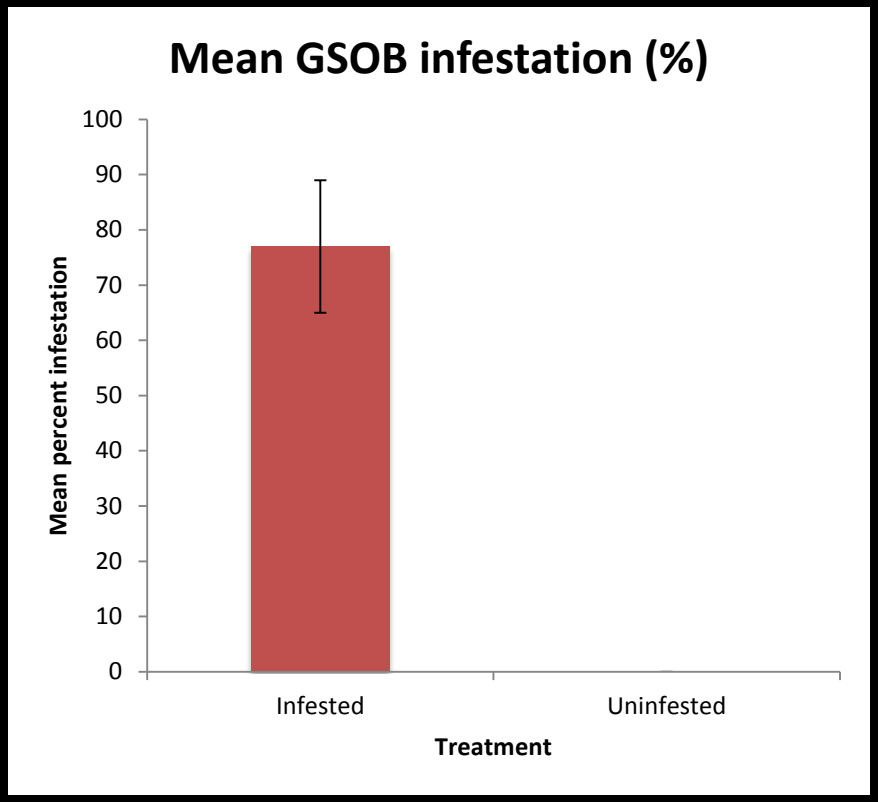


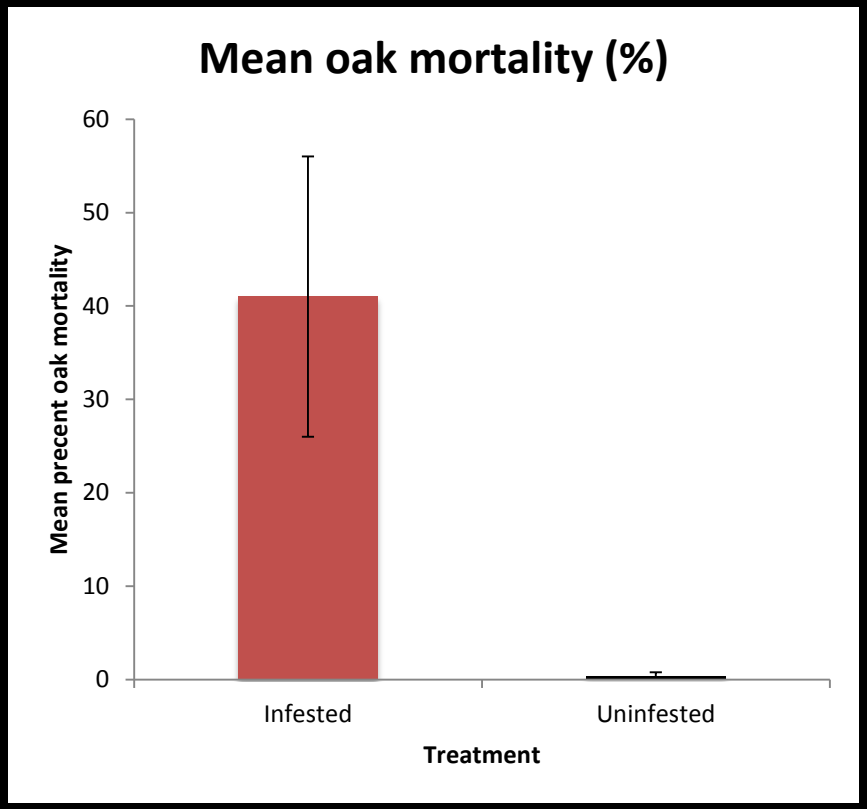




- No significant differences in forest stand characteristics

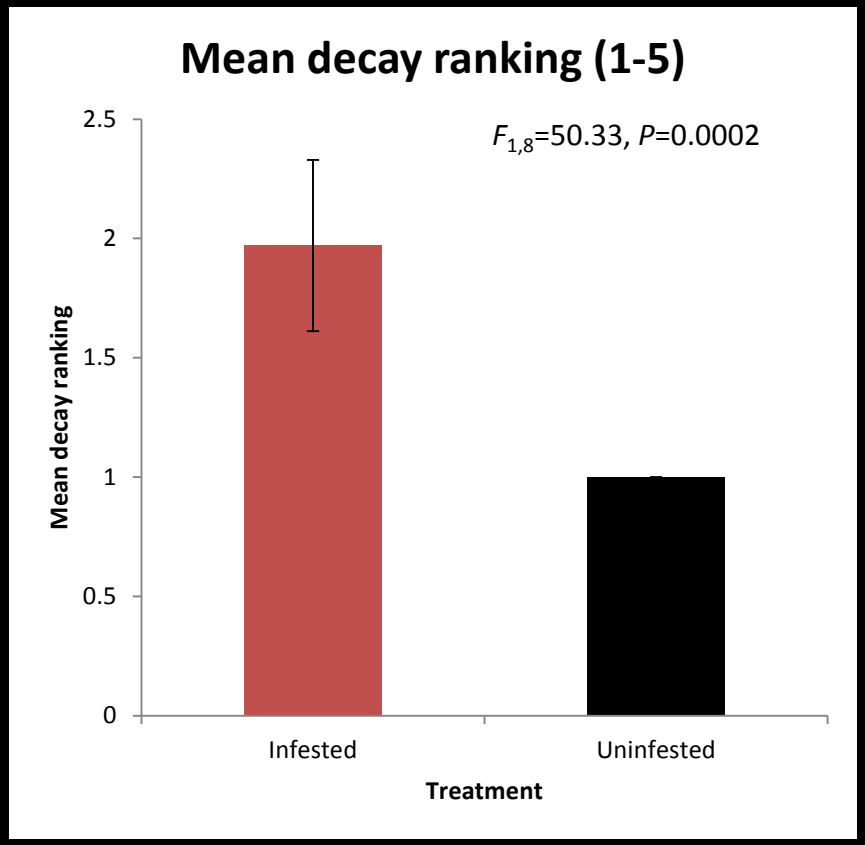
Preliminary data: Forest composition

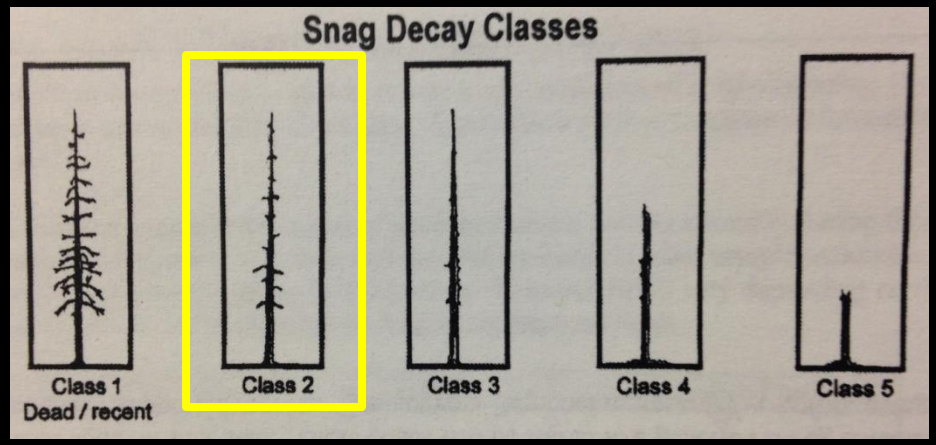




- >10 yrs of GSOB injury in infested stands
  - Mean infestation rate: 77%
  - Mean oak mortality rate: 41%

Preliminary data: Canopy fuels



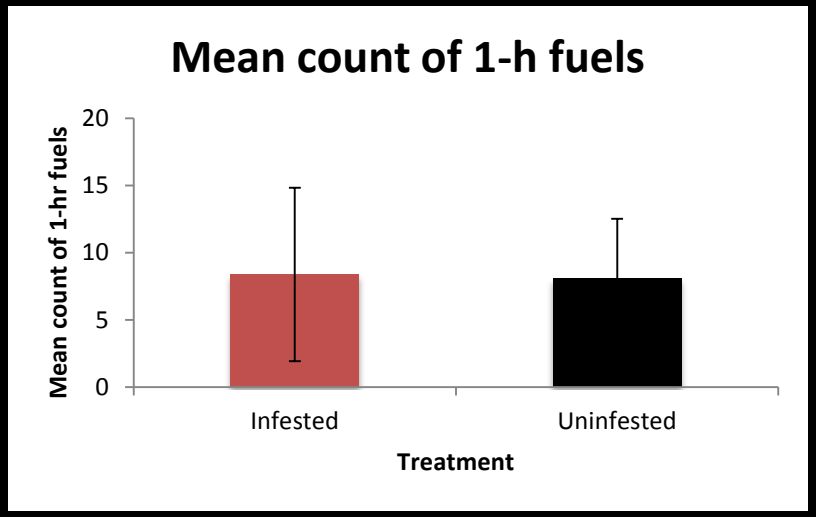


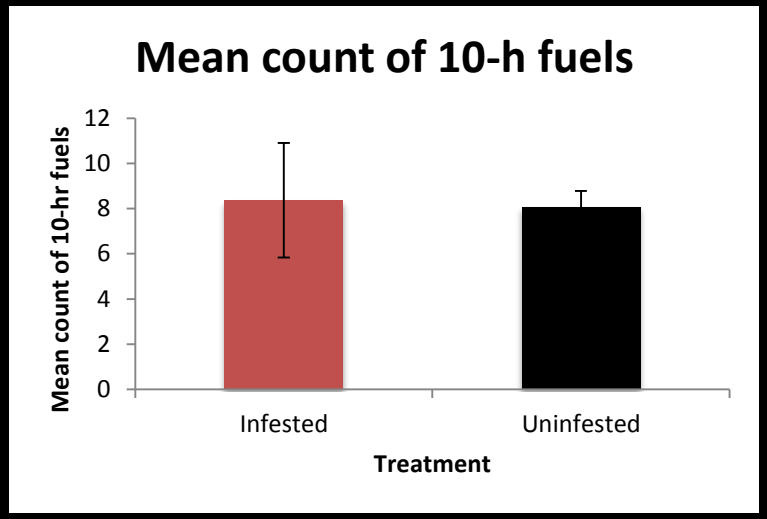
Snag Decay

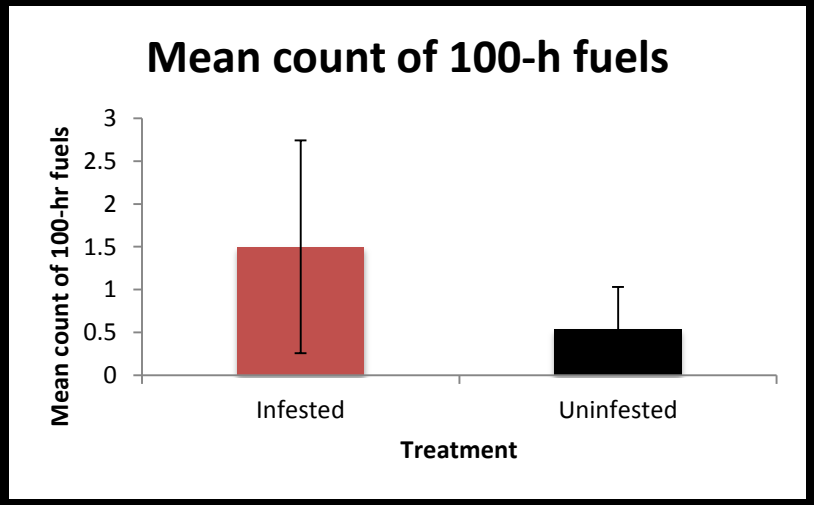
Code	Bark	Heartwood Decay	Sapwood Decay	Limbs	Top Breakage	Bole Form	Time Since Death
1*	Tight, intact	Minor	None to incipient	Mostly Present	May be present	Intact	≤5 years
2	50% loose or missing	None to advanced	None to incipient	Small limbs missing	May be present	Intact	>5 years
3	75% missing	Incipient to advanced	None to 25%	Few remain	Approx. 1/3	Mostly intact	>5 years
4	75% missing	Incipient to advanced	25%+	Few remain	Approx. 1/3 to ½	Losing form, soft	>5 years
5	75%+ missing	Advanced to crumbly	50%+ advanced	Absent	Approx. ½+	Form mostly lost	>5 years

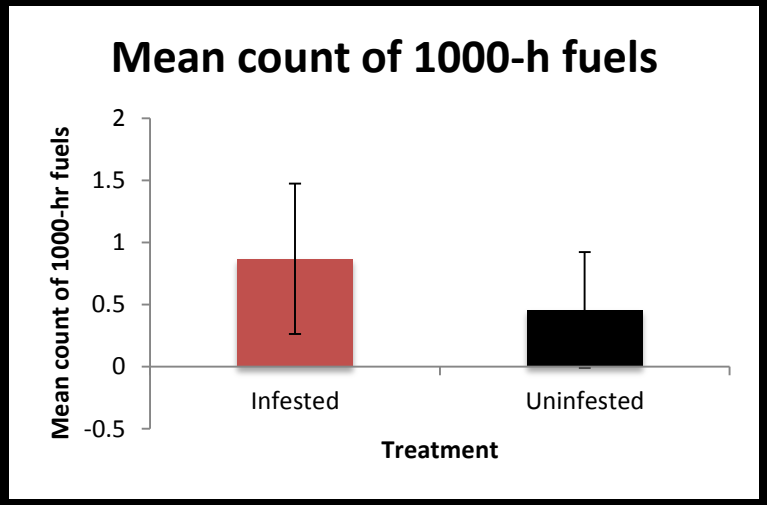
- Dead oaks have decayed very little
  - Bole still intact, large branches present, small limbs mostly missing

Preliminary data: Surface fuels









- An increase in 1-, 10-, 100-, and 1,000-h fuels in infested stands, but not significant

GSOB impacted stands

- Following >10 yrs, oak mortality:
  - Could see greater rates of spread, flame lengths, and fireline intensities

GSOB and Sudden Oak Death fuel loading

- Decay of dead oaks related to GSOB-caused tree mortality can be similar to SOD

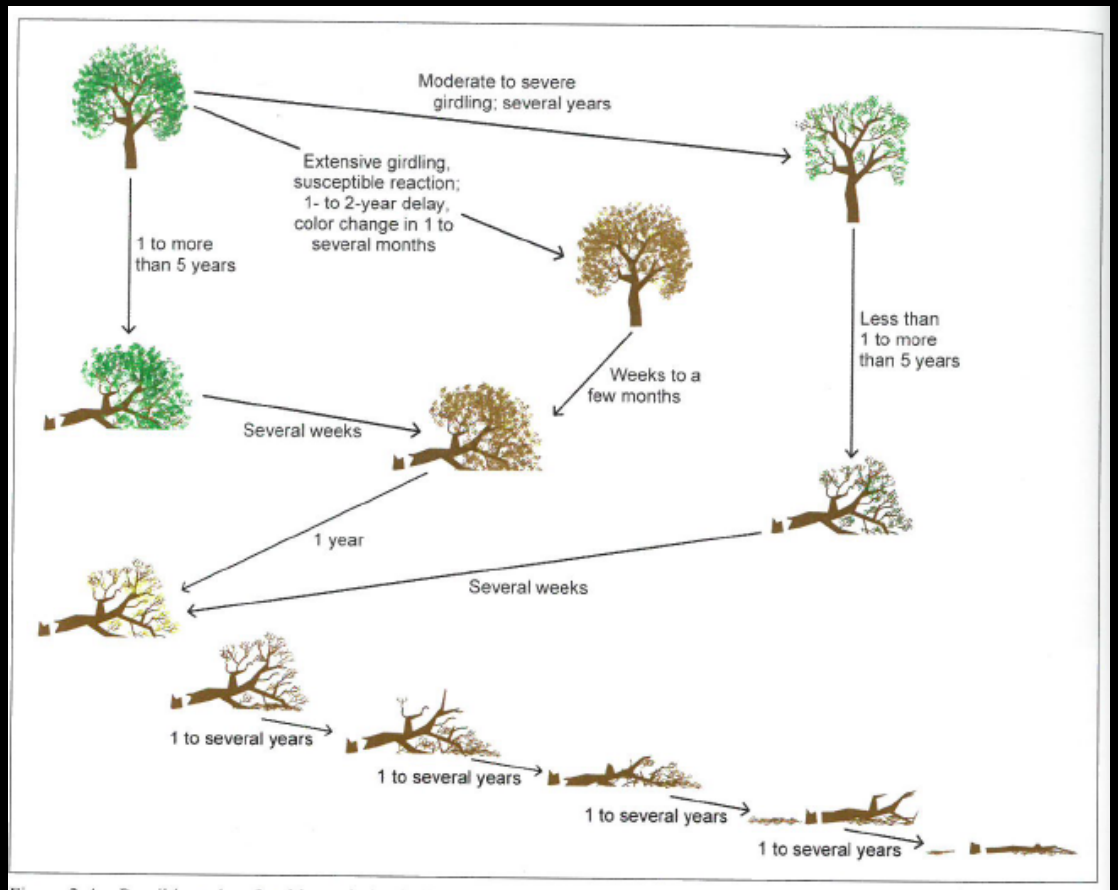


Figure 2-4—Possible paths of sudden oak death disease progress and eventual tree degradation in coast live oaks that fail while the top is still live (green failure) or within a short time after rapid death of the canopy. Trees following this pattern typically have large amounts of preexisting wood decay in the trunk or other severe structural defects, and are extensively colonized by secondary decay fungi and beetles. Green tree at upper left represents a newly infected tree with bleeding cankers only.

From T.J. Swiecki and E.A. Bernhardt. 2013. A Reference Manual for Managing Sudden Oak Death in California

PSHB impacts

- Greater rate of change in 100-h and 1000-h fuels from PSHB?
  - Branch and stem failure due to PSHB galleries

Acknowledgements

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  - Michael Jones (UC, Davis)
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  - Daniel Betancourt (FHP)

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  - UC, Riverside, Department of Entomology and Plant Pathology
  - UC, Davis, Department of Entomology and Nematology