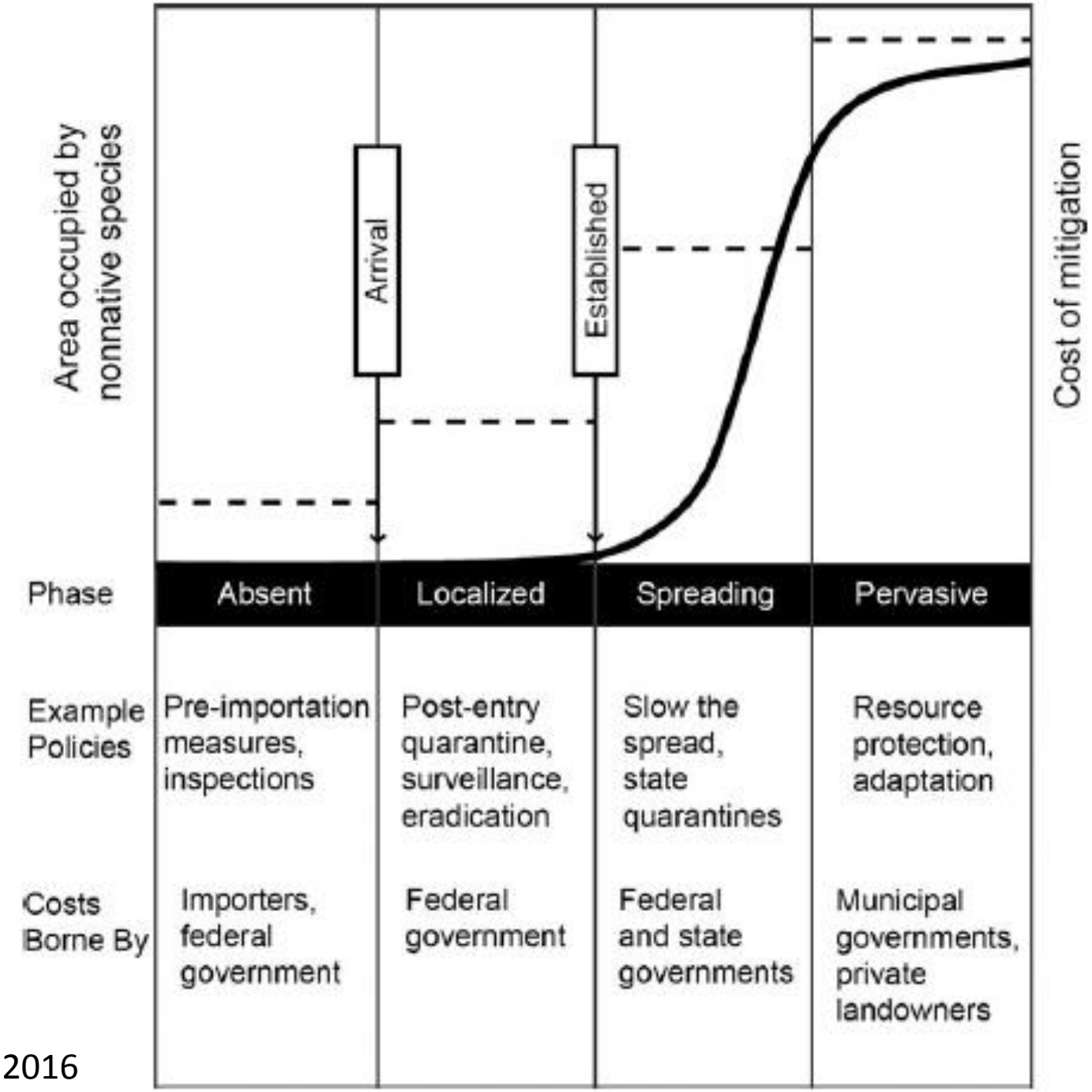
Restoring sudden oak death impacted forests of Mt. Tamalpais

Richard C. Cobb, David M. Rizzo & Kerri Frangioso, Department of Plant Pathology, UC Davis;

Peter Hartsough, Department of Land Air and Water Resources, UC Davis;

Janet Klein, Mike Swezy, Andrea Williams, & Carl Sanders, Marin Municipal Water District

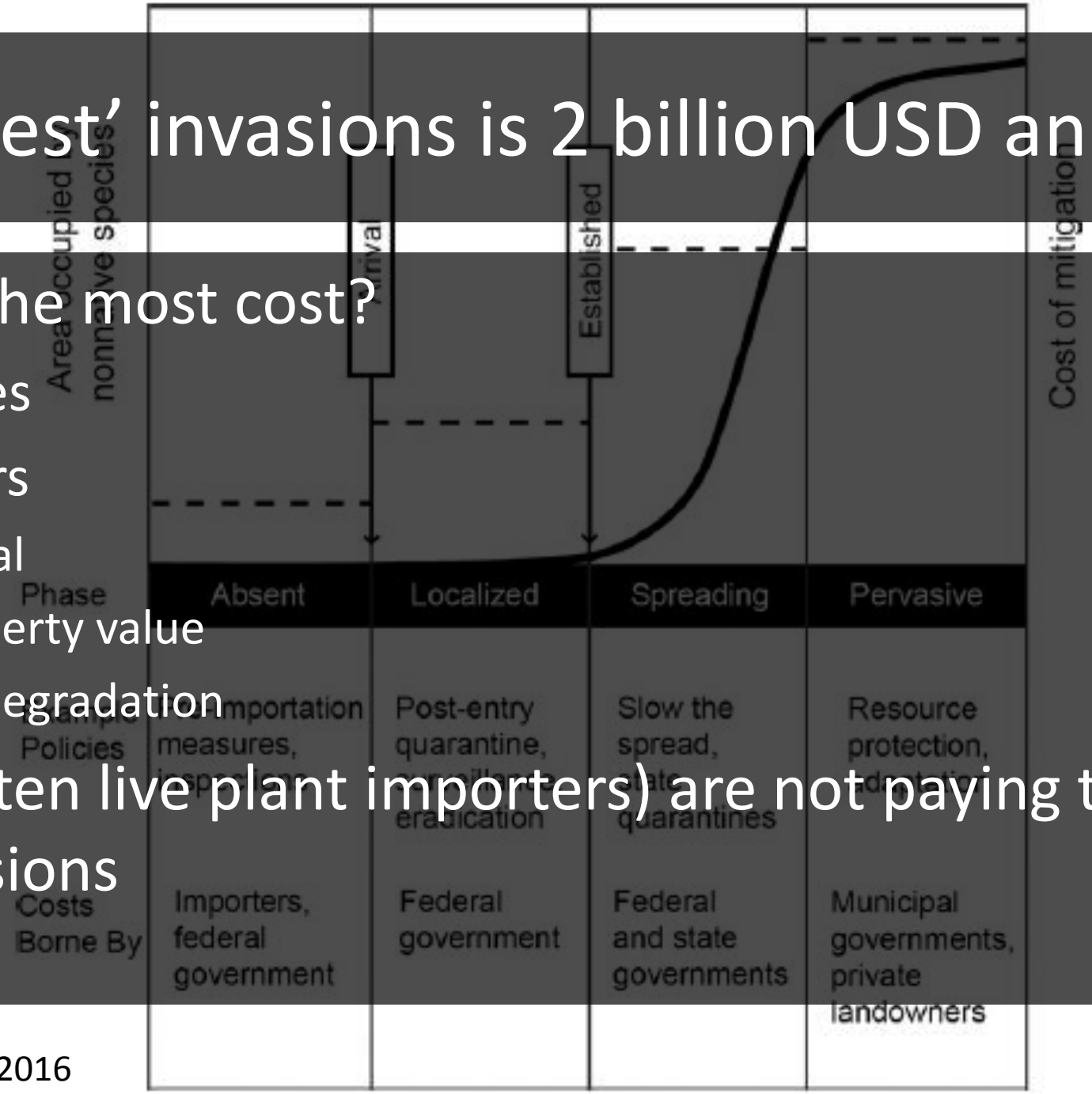
Susan J. Frankel, Pacific Southwest Research Station, USDA Forest Service



Lovett et al 2016

Costs of ‘pest’ invasions is 2 billion USD annually

- Who carries the most cost?
  - Municipalities
  - Home owners
    - tree removal
    - loss of property value
    - Ecological degradation
- Importers (often live plant importers) are not paying the costs of these invasions



Lovett et al 2016

Photo: Deborah Bruce-Hostler

Energy and Environment

This disease is killing California trees by the millions, but scientists urge against giving up

By Chris Mooney May 16

Most Read

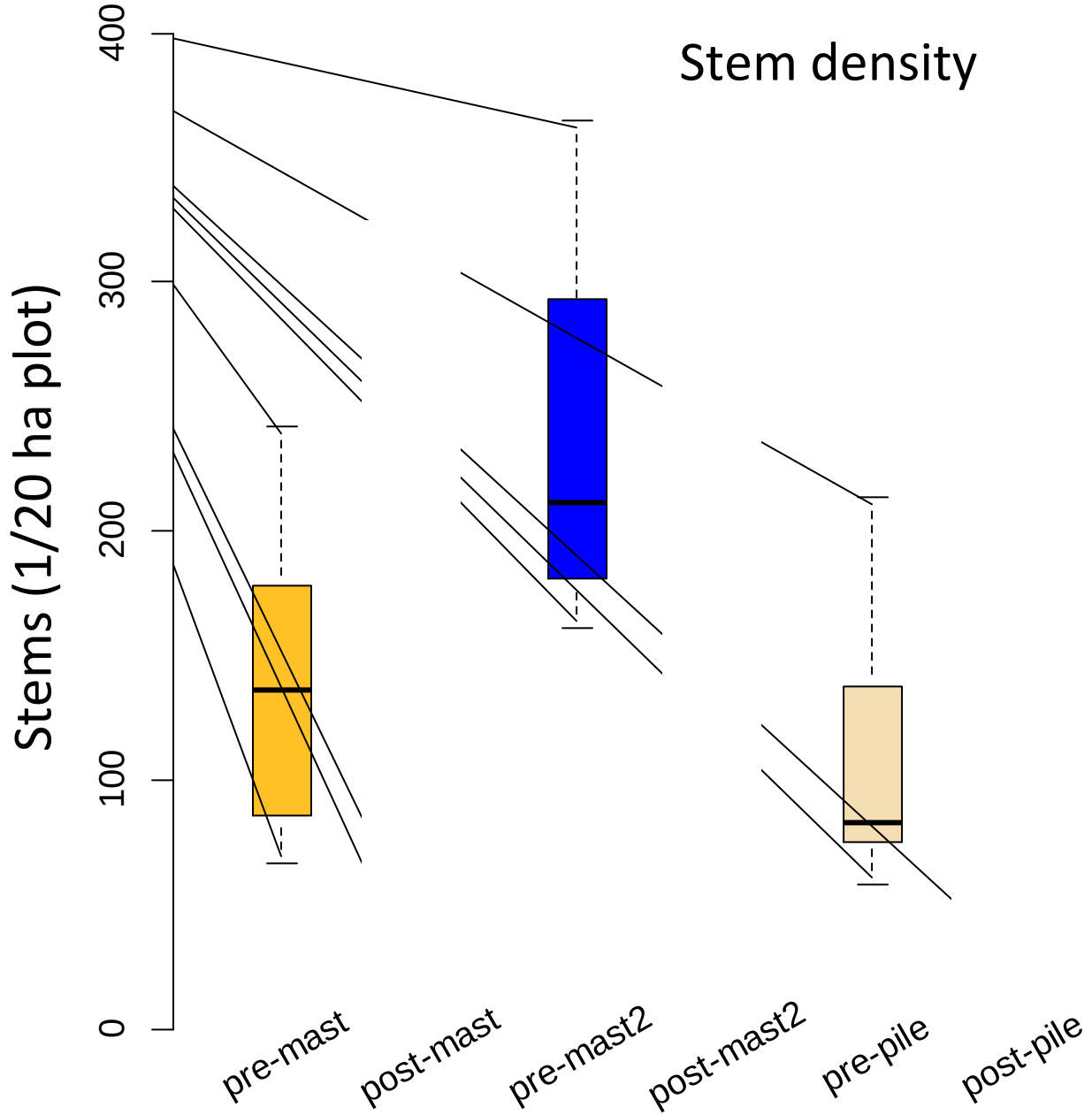
1 U.S. will spend $2.6 trillion less on health care than expected before Obamacare, study projects
2 Now we know what happens to teens when you make pot legal
3 Why the upper middle class might be the real target of today's anger
4 Wall Street is sitting on billions meant for American charities
5 Don't buy a 'wedding dress' for your wedding

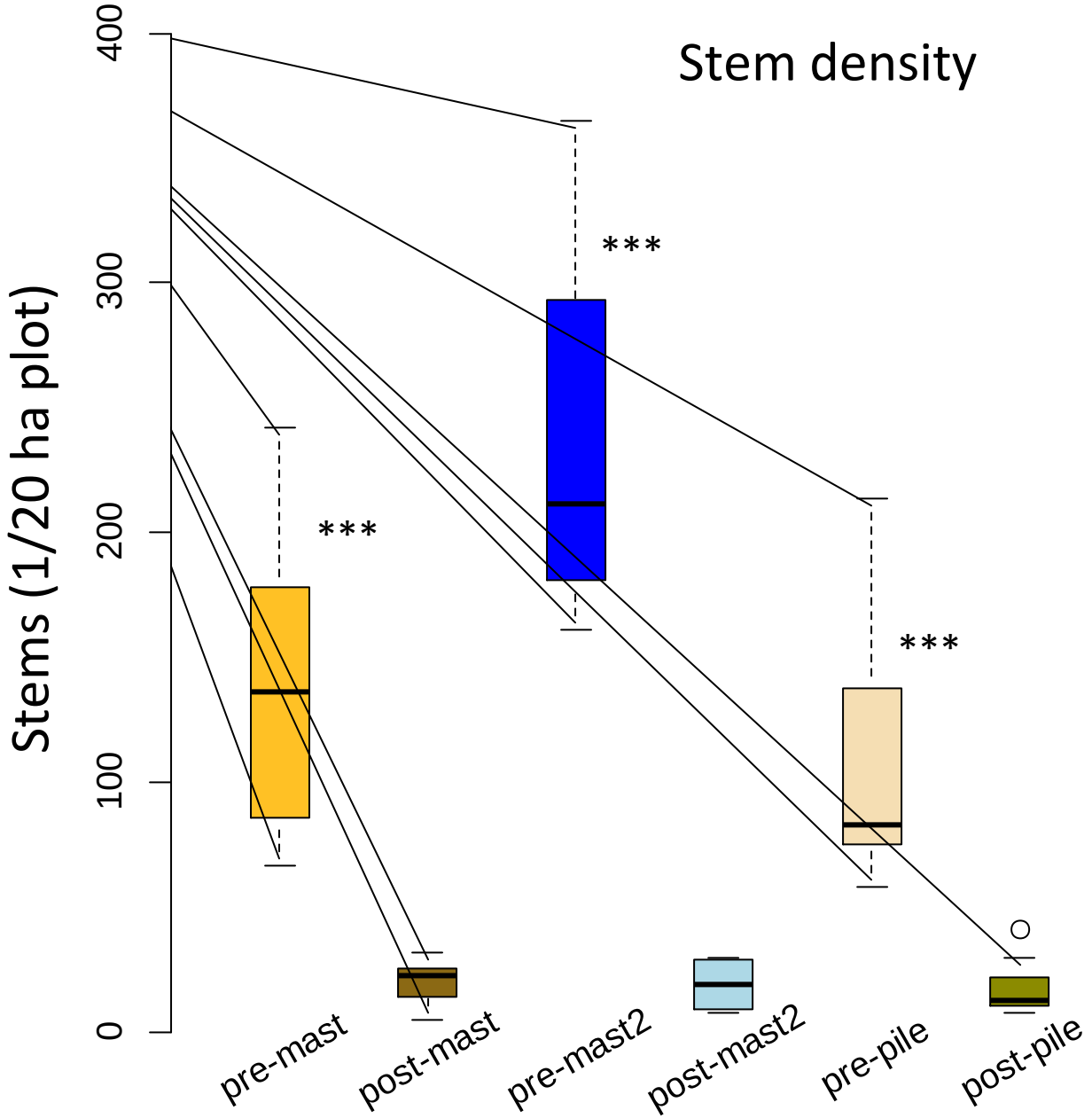
Study Design

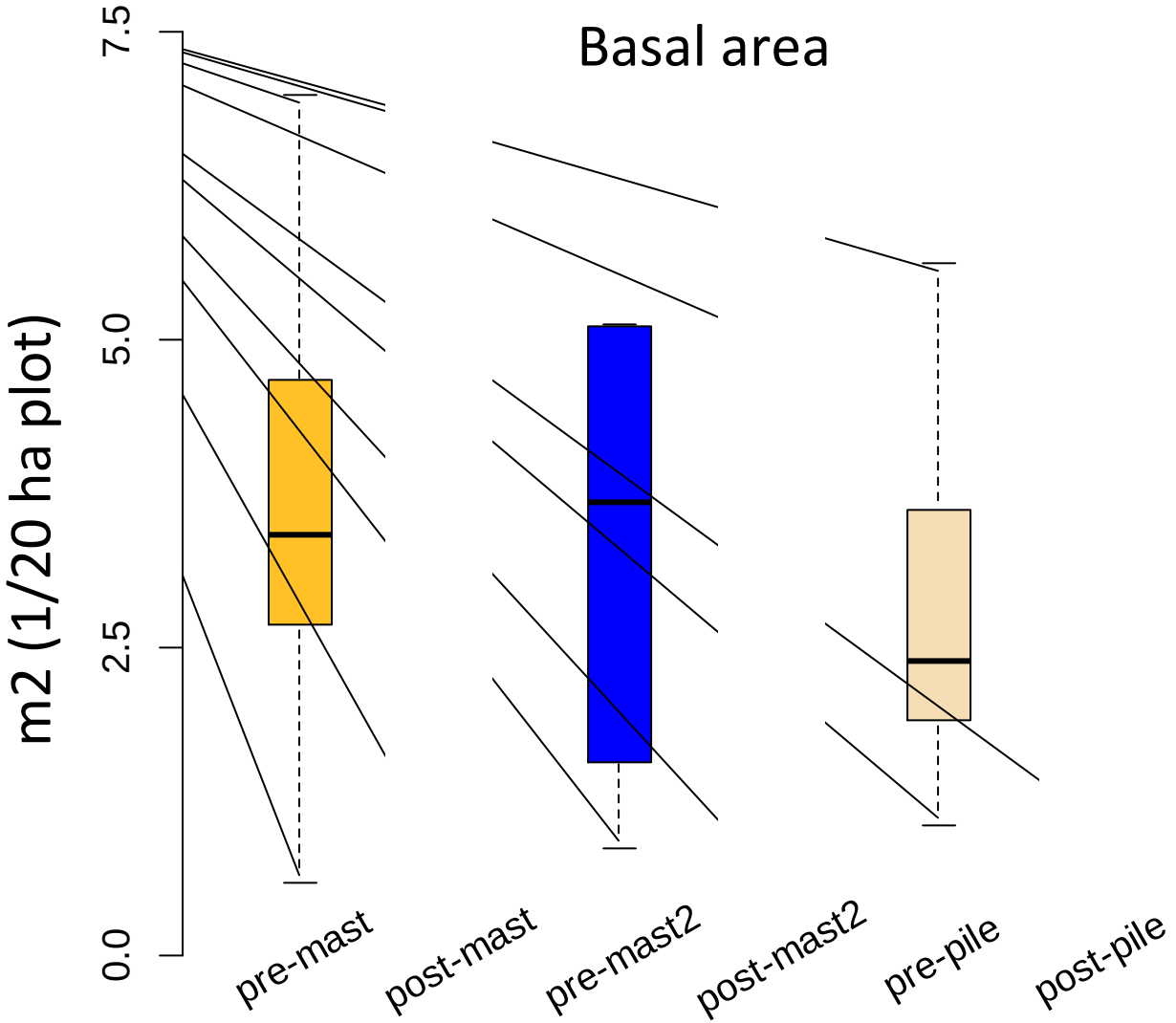
- Goal: increase **carbon sequestration** while **reducing fuels** and increasing **water provisioning**
- Treatments: Understory vegetation removal and ground fuel reduction
  - Mastication (8) (excavator/masticator)
  - Mastication of hand-crew piles (7)
  - Fuel piles (10)
    - Half of piled plots were burned
  - Untreated reference (5)

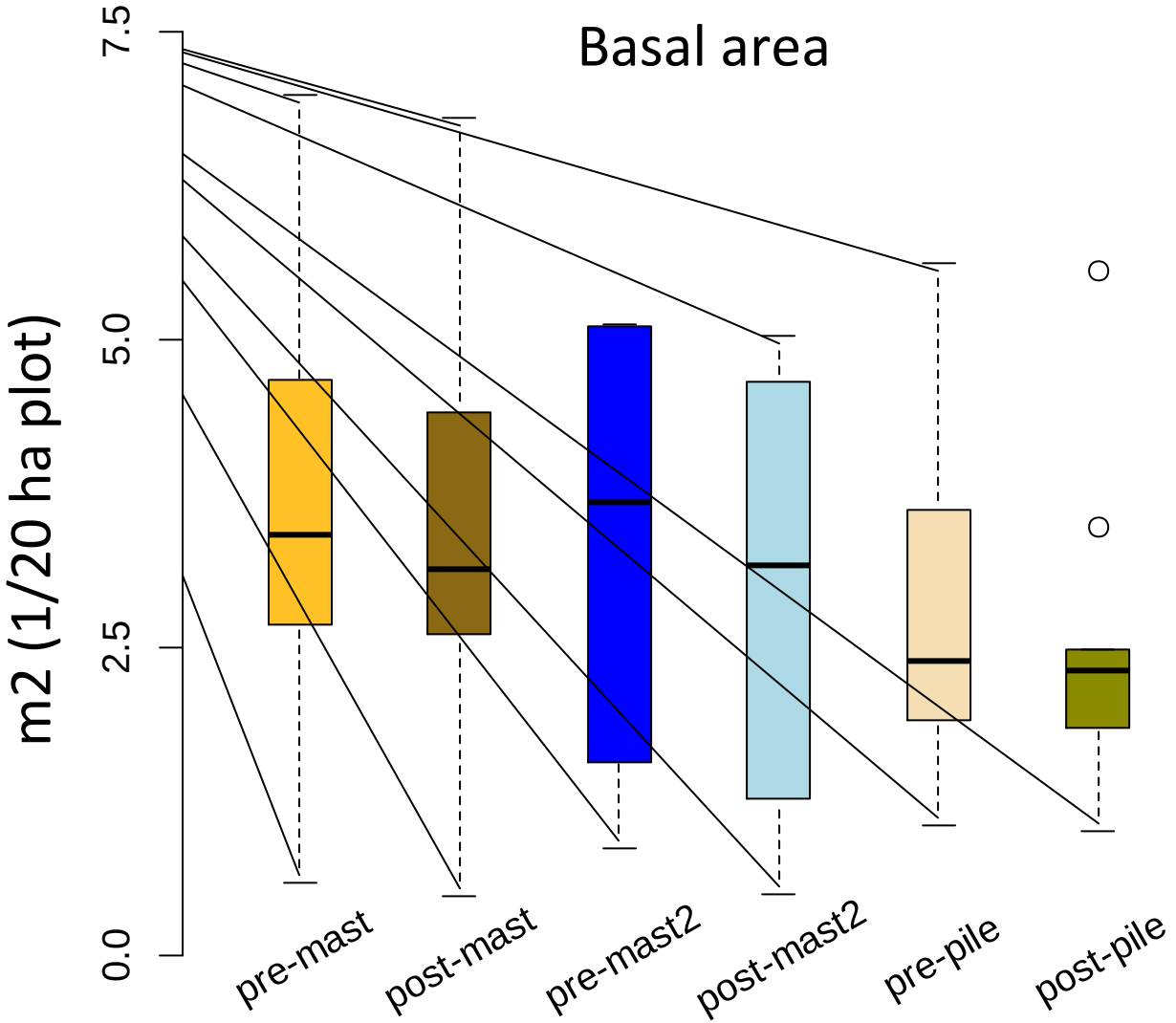

CAT
RPILLAR
GB3T44
DANGER
STAY BACK
314C LCR
CAT

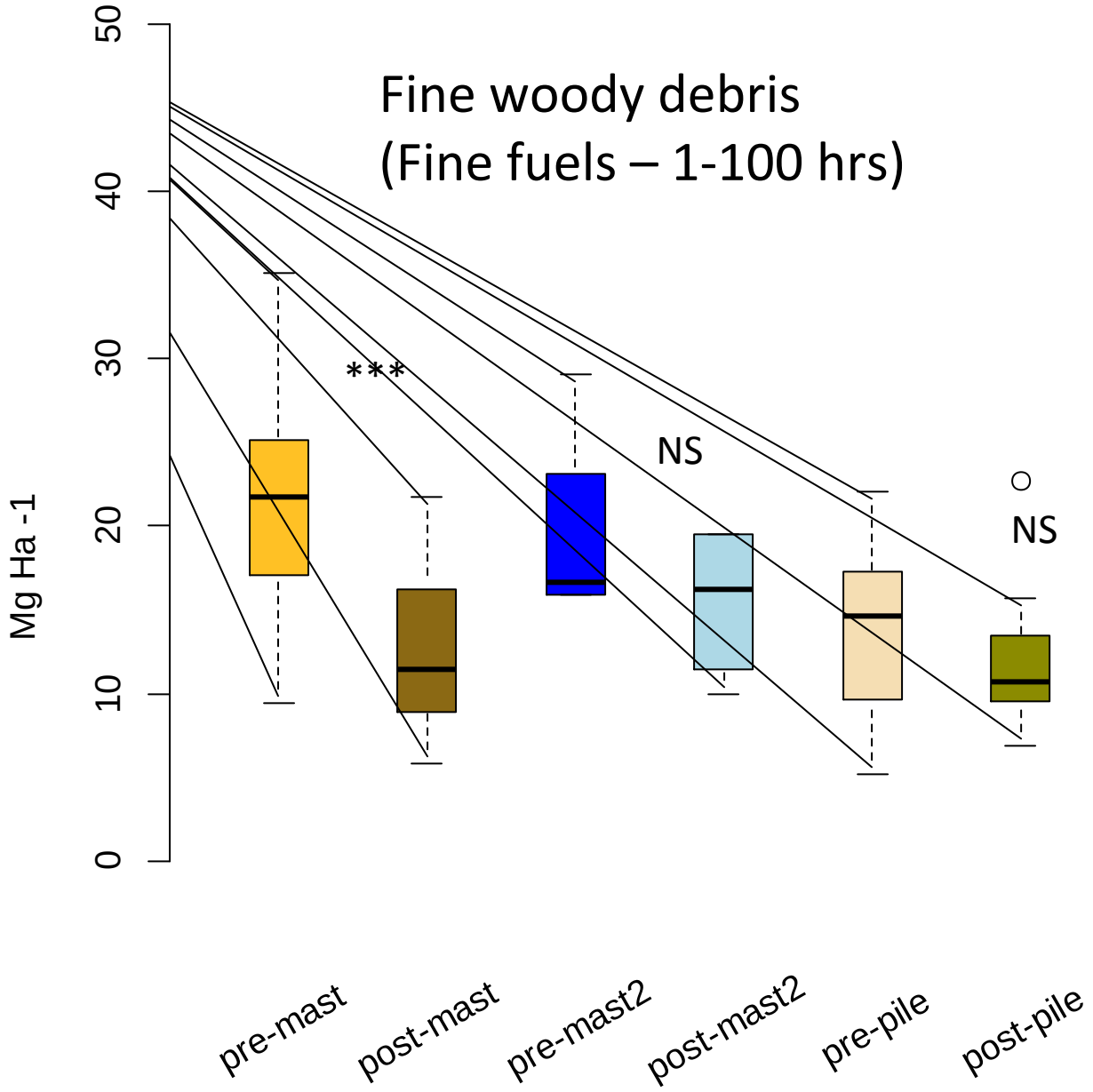

CAT
RG6J99
299C

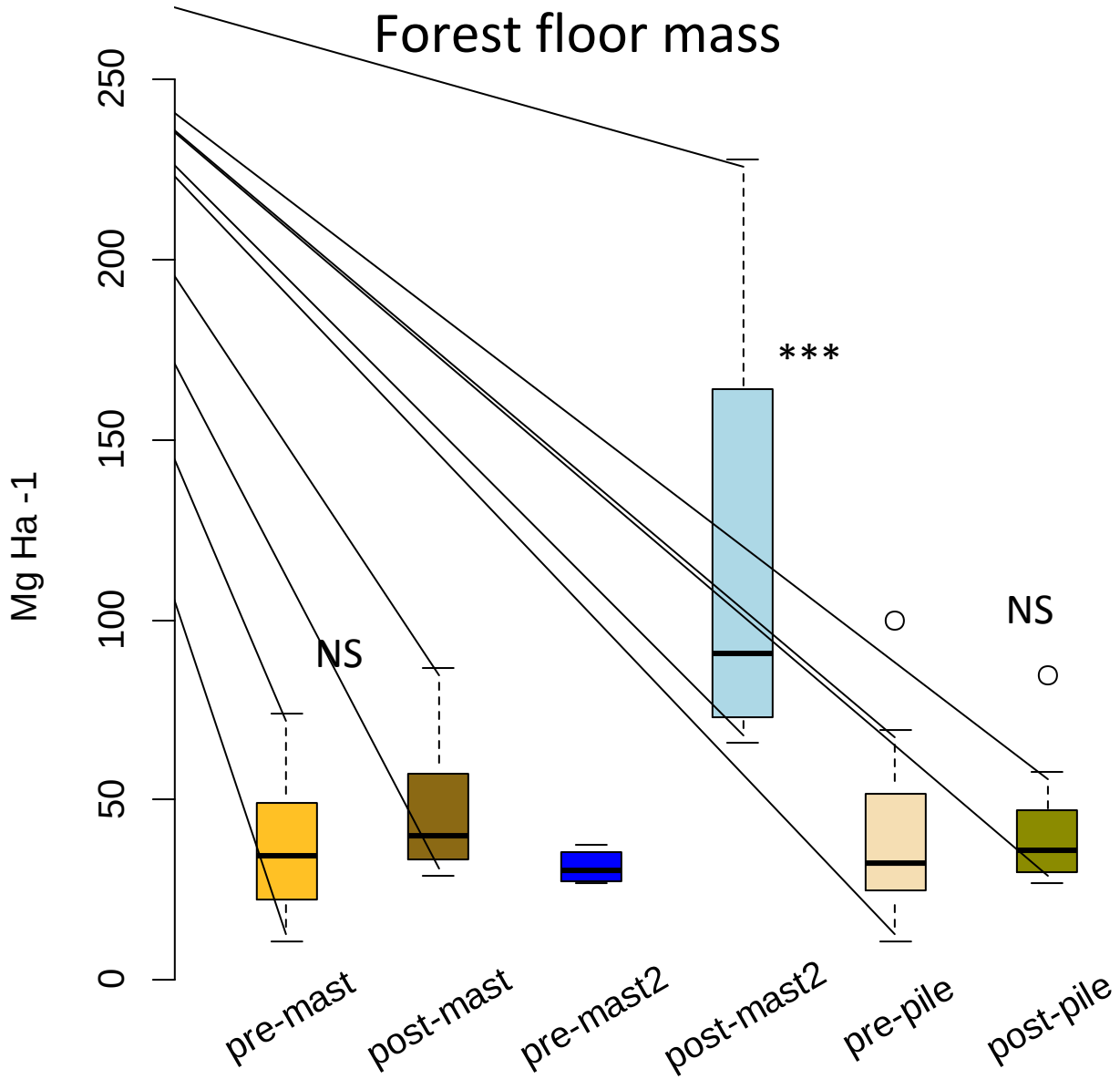

Stem density
Stems (1/20 ha plot)
0
100
200
300
400
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile

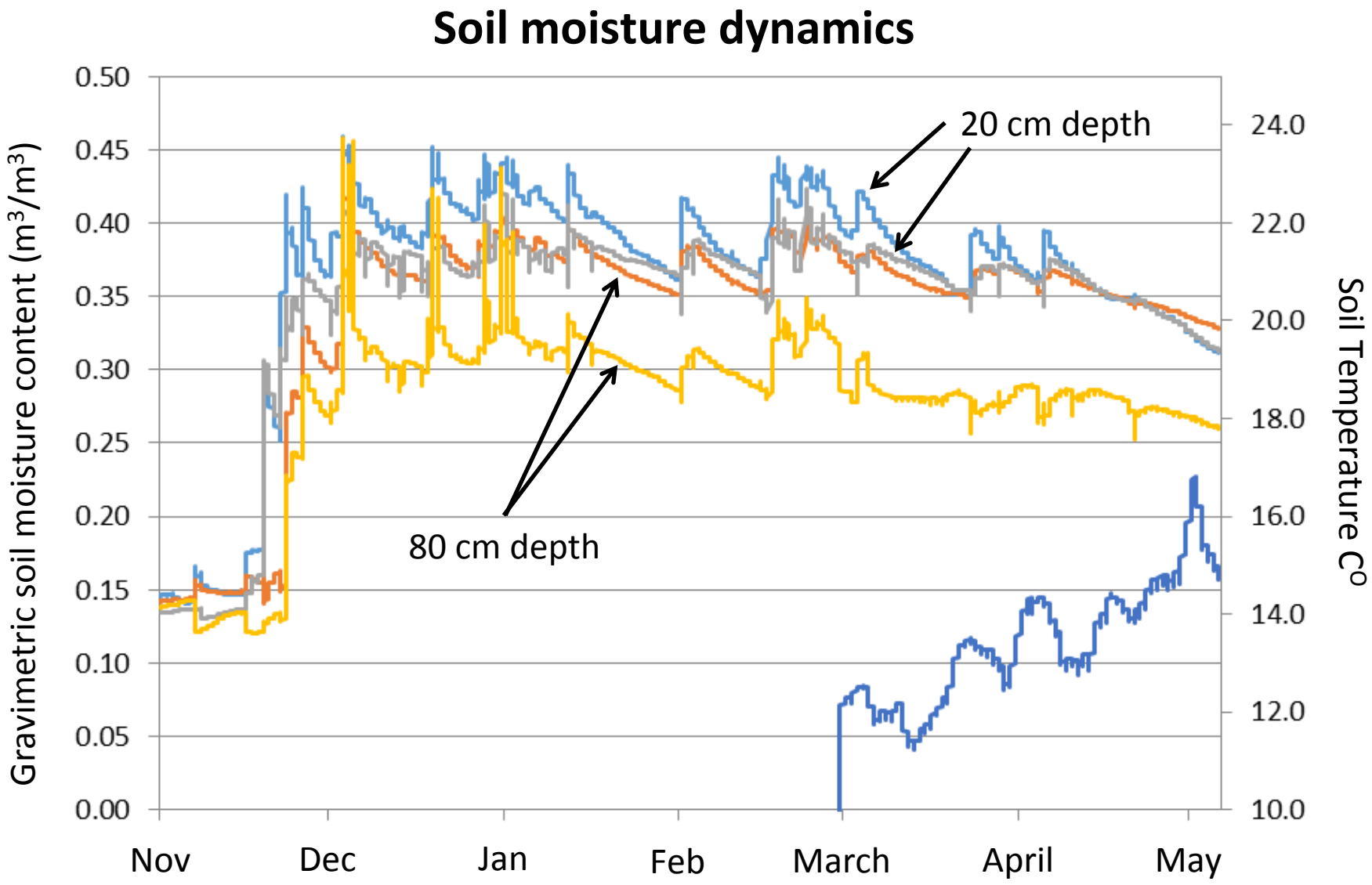

Stem density
Stems (1/20 ha plot)
0
100
200
300
400
***
***
***
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile


Basal area
m2 (1/20 ha plot)
7.5
5.0
2.5
0.0
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile

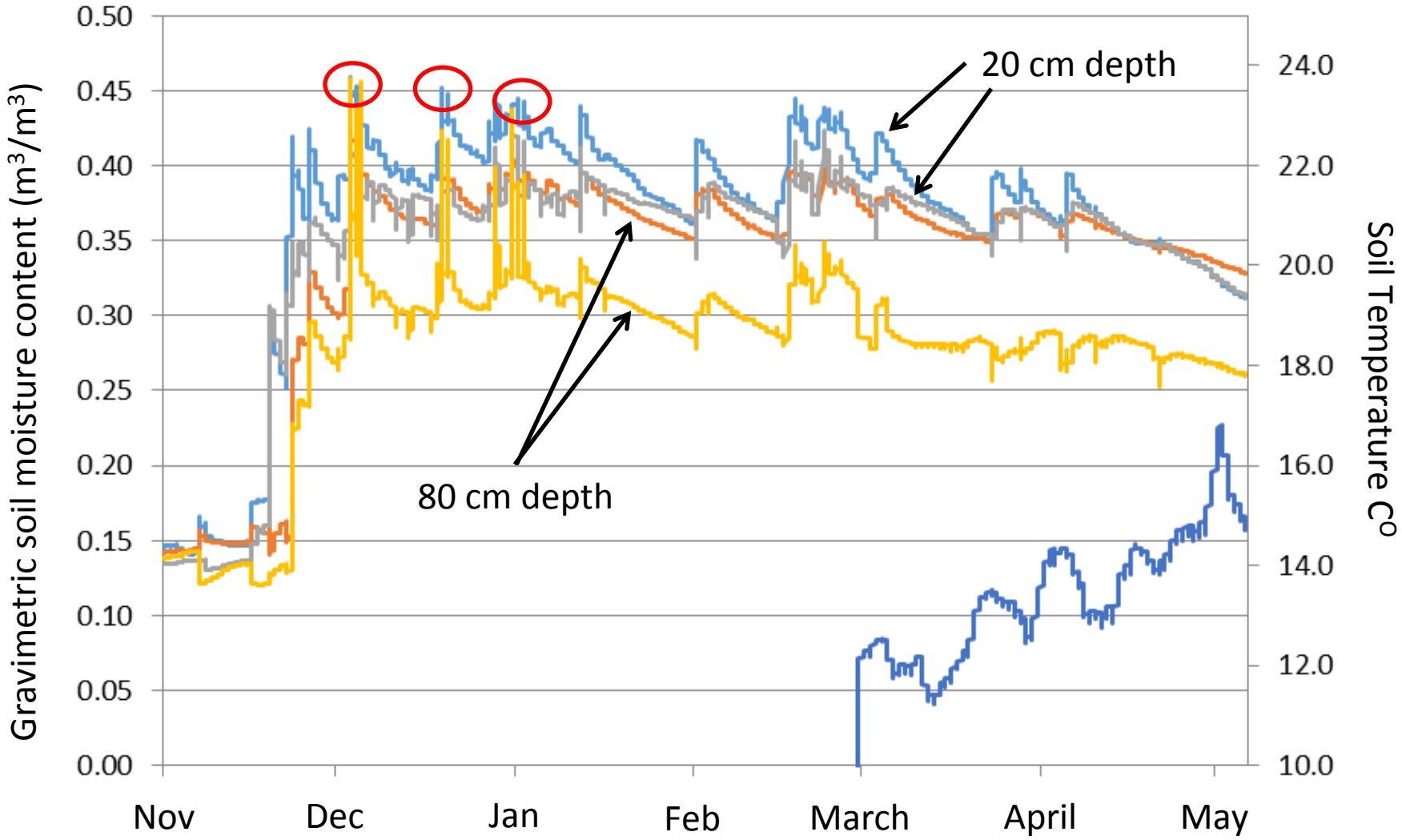

Basal area
m2 (1/20 ha plot)
7.5
5.0
2.5
0.0
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile


Fine woody debris
(Fine fuels – 1-100 hrs)
Mg Ha -1
0
10
20
30
40
50
***
NS
NS
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile


Forest floor mass
Mg Ha -1
0
50
100
150
200
250
***
NS
NS
pre-mast
post-mast
pre-mast2
post-mast2
pre-pile
post-pile


Soil moisture dynamics
Gravimetric soil moisture content (m3/m3)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Nov
Dec
Jan
Feb
March
April
May
20 cm depth
80 cm depth
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
Soil Temperature Co

Soil moisture dynamics



Results

- Goal: increase **carbon sequestration** while **reducing fuels** and increasing **water provisioning**
- Reduced stand density (all treatment types)
- Altered fuel bed (compacted)
- Transferred carbon to the forest floor

Cost-benefit analysis

- Treatment costs –
  - Approximately $12,000 ac
  - Replanting and follow-up costs expected ~$8,000 ac
- What factors drive costs?
- MMWD budgeted for $750,000 in vegetation management for the next 2 years

- Fuels
  - Reduced stand density
  - Compacted fuel bed
- Benefits
  - Carbon sequestration
    - Soil
    - Vegetation
- Water
  - Outflow to groundwater recharge

Acknowledgements

Funding: Cal Fire - Greenhouse gas emissions reductions program, MMWD, USDA-PSW
Many cooperators including NPS, One Tam, Parks Conservancy, Marin County Parks, GGNRA
Elliot Gunnison
Emily West
Darrell Patchin
J. Fouche
L. Offenbach
Linnea Whitney
and many others

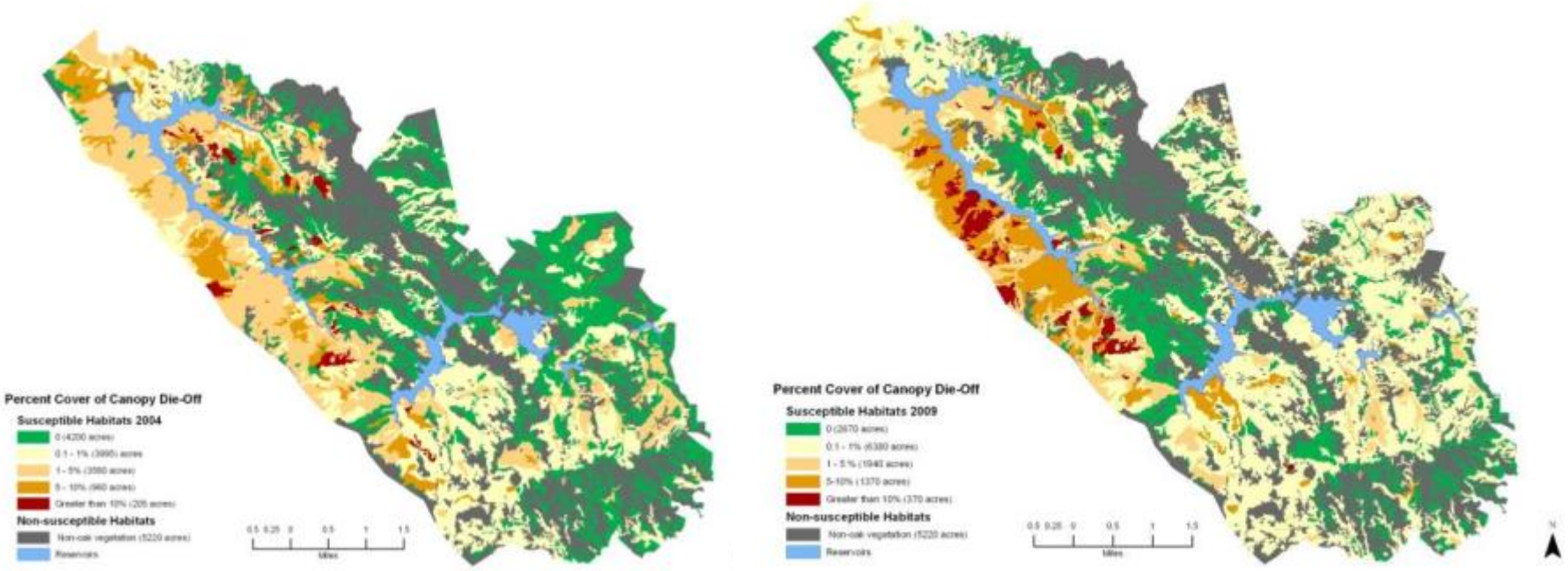
MARIN MUNICIPAL
WATER DISTRICT

Resilient Forest Cooperative Research Project

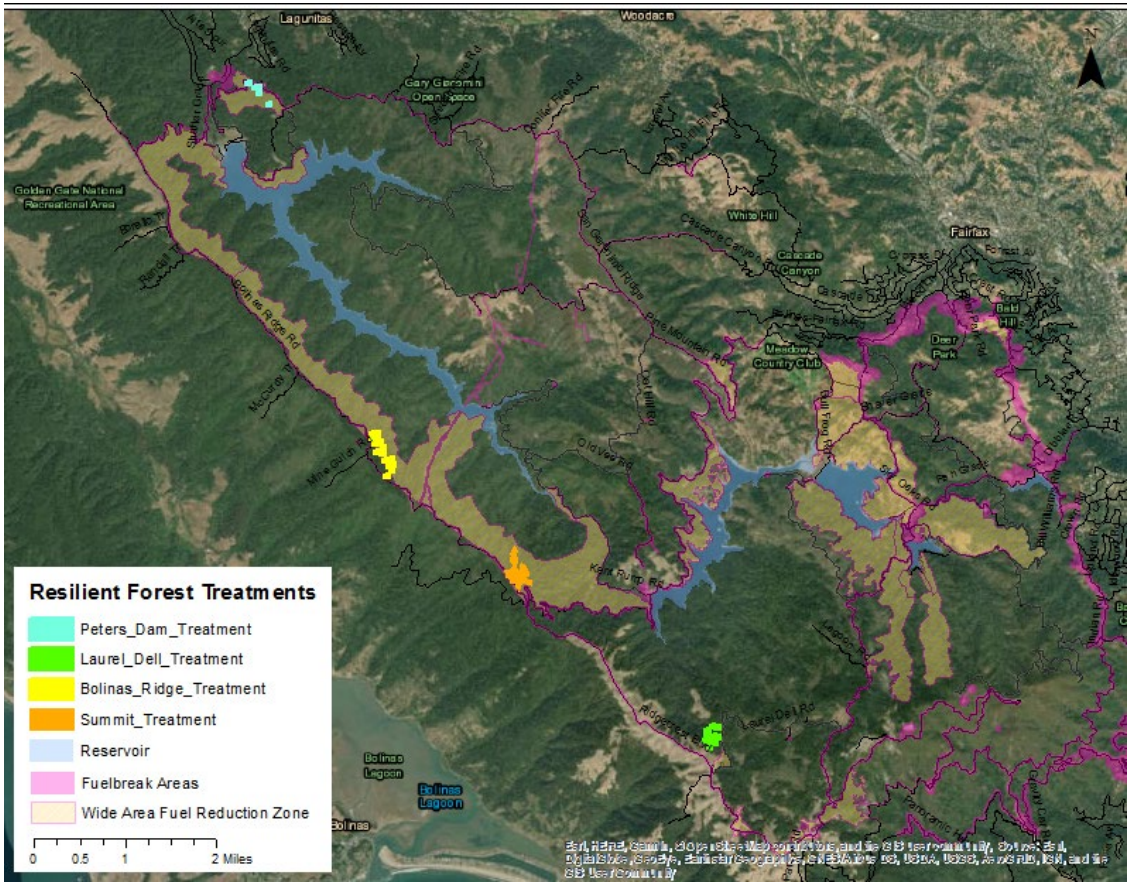
Resilient Forest Project

Identify forest restoration treatment methods for Sudden Oak Death impacted forests that reduce understory fuel loads and enhance ecosystem services of watershed lands.

Sudden Oak Death Impacted Forests 2004 & 2009



Resilient Forest Cooperative Research Project



Project Objectives

- Reduce brush
- Reduce fuel
- Increase tree diameter
- Improve fire resiliency
- Optimize carbon storage
- Optimize water yield
- Improve habitat value

Project Partners: MMWD, U.S Forest Service, Cal Poly State University, University of California Davis, and One Tam

Resilient Forest Project-Research

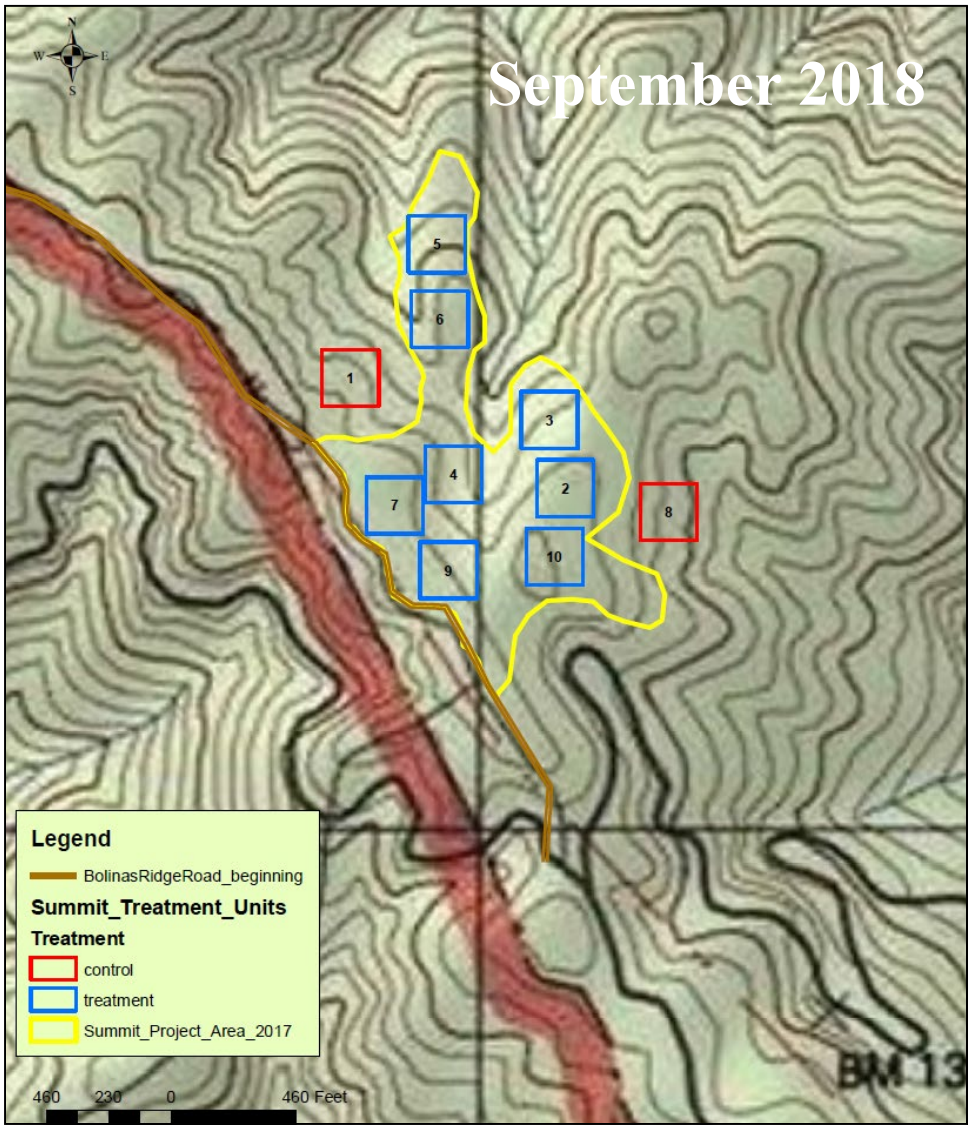
Research Elements

- Hydrological Monitoring (UC Davis)-Quantify changes in water yield associated with treatment methods. GIS based model of the watershed that evaluates water yield from treated and control areas of the watershed.

- Carbon Monitoring (Cal Poly)-Quantify soil greenhouse gas dynamics, shifts of canopy carbon to the forest floor, and carbon sequestration from above ground productivity. Evaluate post treatment carbon storage in tree biomass by measuring tree growth, 5-year disease caused mortality, and natural recruitment.

- Vegetation Monitoring and Reforestation (USFS & MMWD)-Monitor natural recruitment at all treatment sites and evaluate species composition. Collect native seeds to support the implementation of the reforestation plan.

Resilient Forest Project- Treatment Sites 2018



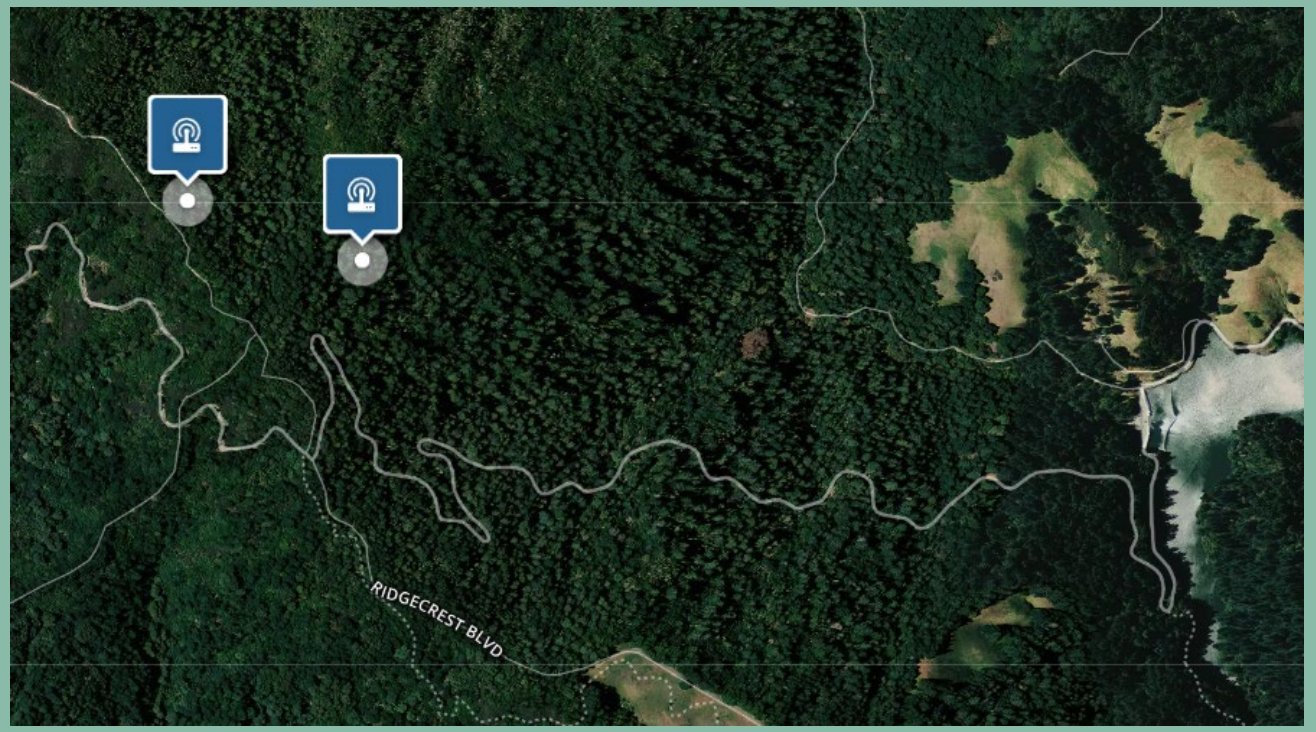
Treatment Plot 2-September 2018

Treatment Plot 5-September 2018

Treatment Plot 6-September 2018

Example of Post Treatment Forest Conditions

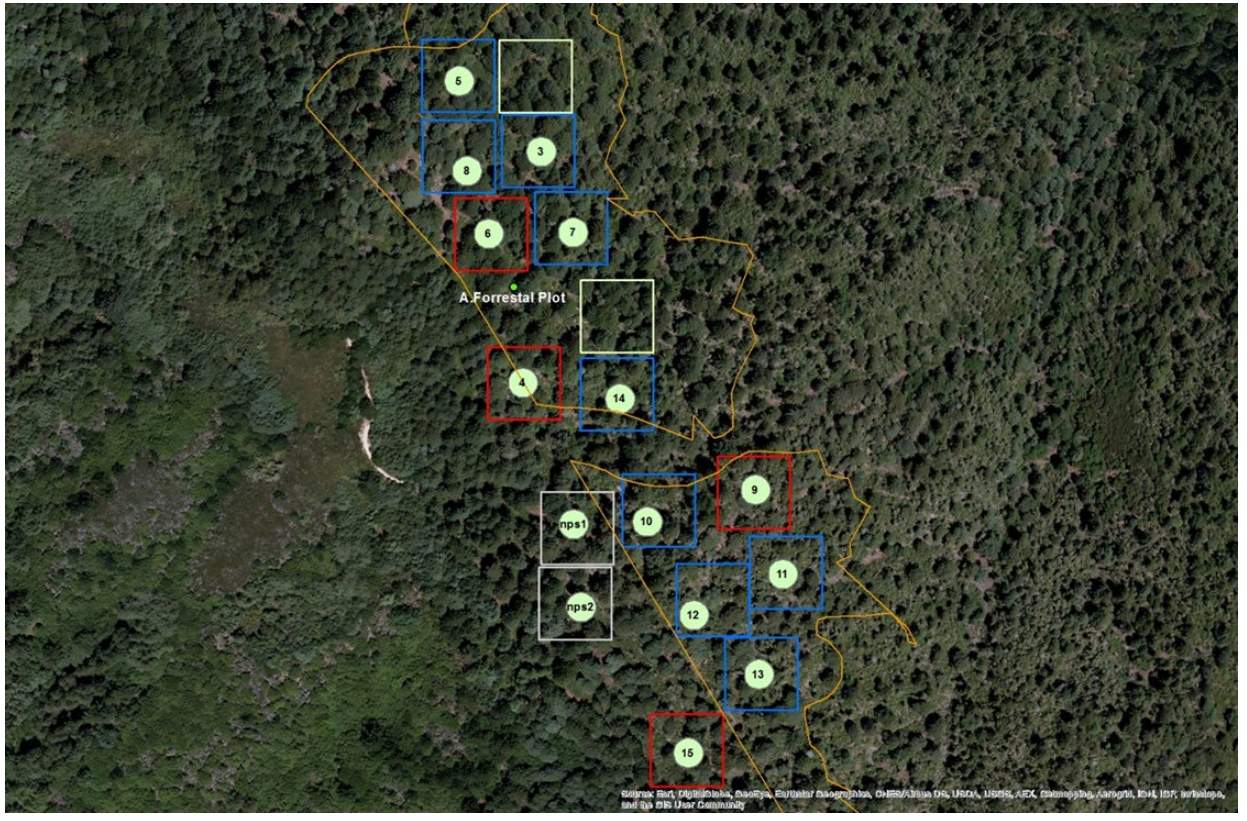
Following the Water: Hydrologic investigations of sudden oak death treatments on Mt. Tamalpais



Peter Hartsough
Hydrologist
University of California, Davis
phartsough@ucdavis.edu

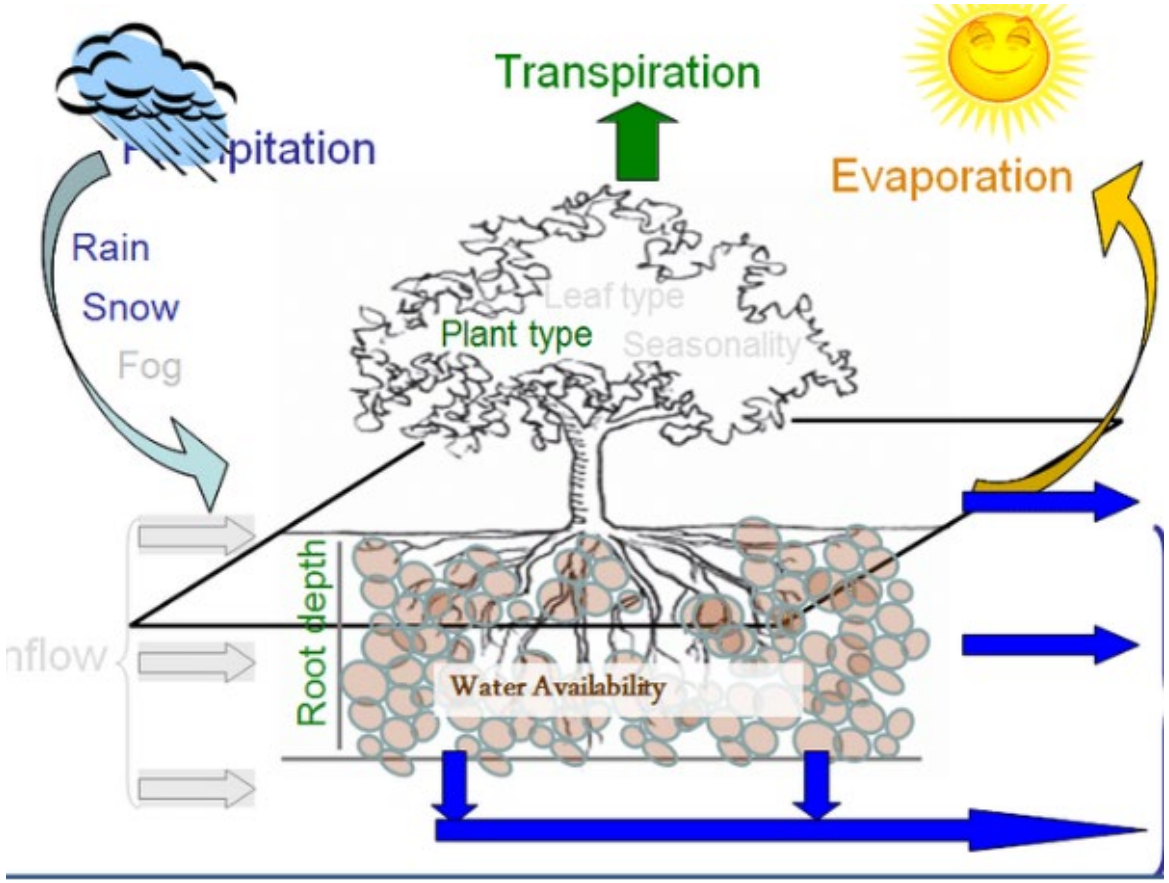
October 5, 2018

- Hydrologic implications of SOD treatments
  - What is water yield? How does it change with land use change?
  - Monitoring: why measure soil moisture?



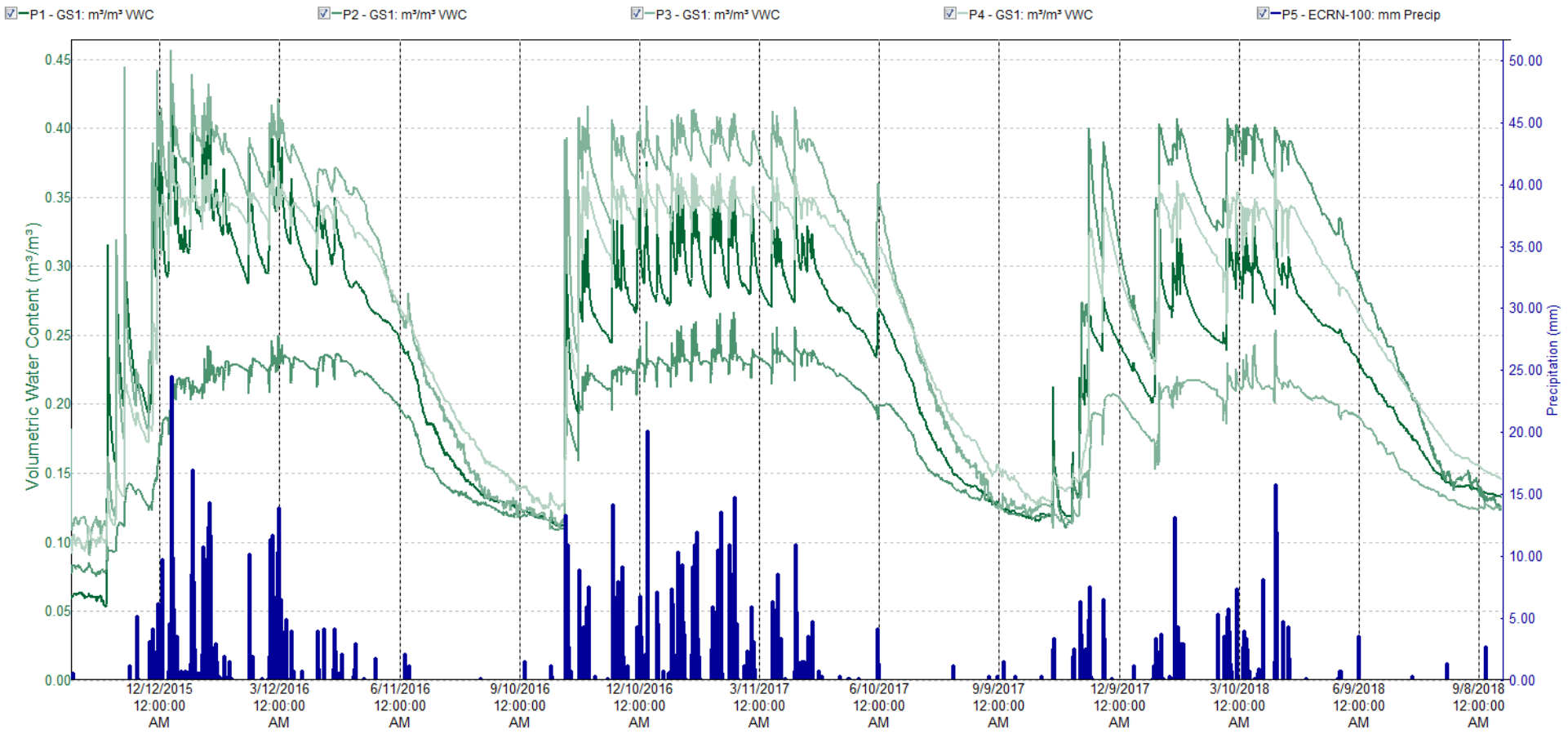
Water Balance

In (precipitation) – out (ET, runoff) = change in storage

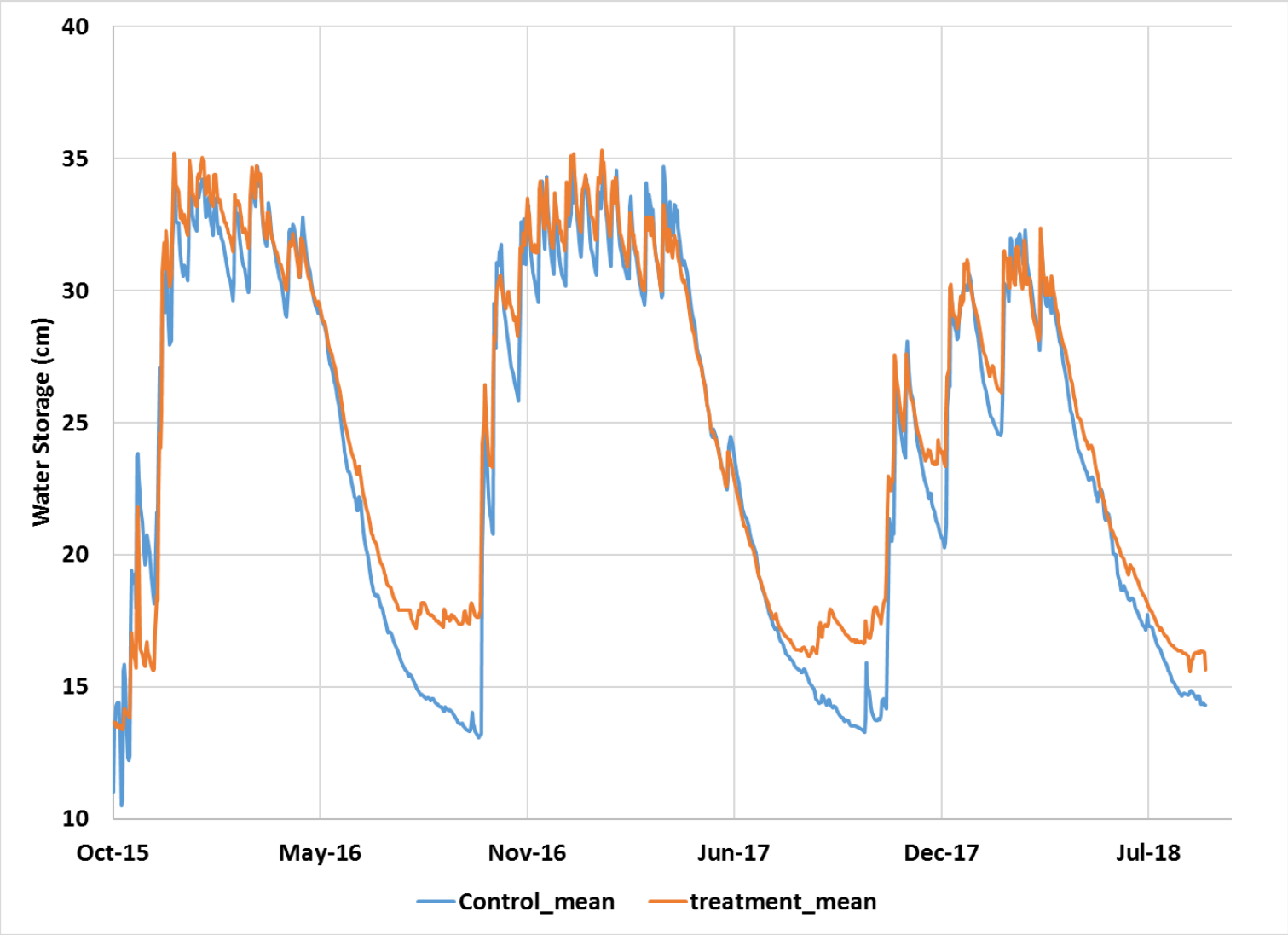



BS1

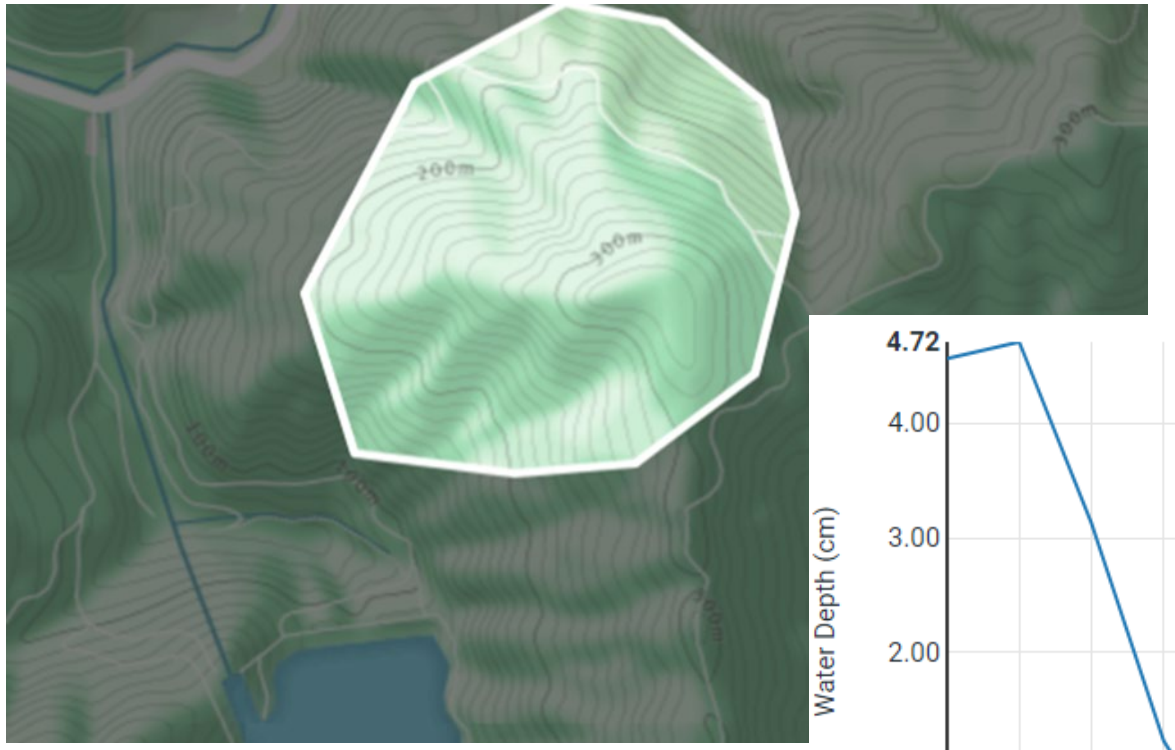
What does the raw data look like?



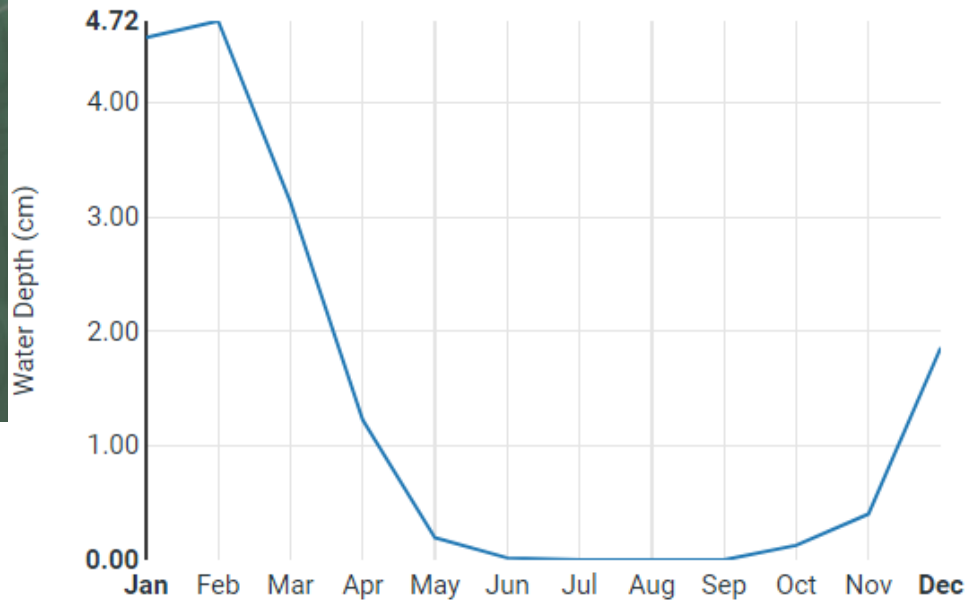
Soil Water Storage



GIS based model



Subsurface Flow



But what about ET?

- ET or drainage dominated? What is happening at different times of the year?
  - Approach: Use Satellite data, Landsat and Planet Labs
  - Use reflectance indices, such as NDVI to look at changes in ET with treatments. Values must be calibrated with measured data from other sites
  - Soil moisture will then become a response variable in the model

In (precipitation) – out (ET, runoff) = change in storage

Wrap up and future directions

- Intriguing results but lots of variability
- Need better estimates of ET to constrain runoff estimates – remote sensing
- New Summit site

Thanks to all the collaborators, MMWD, USFS, CalPoly, many students at UCD

Questions?

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October 5, 2018

An update on sudden oak death, *Phytophthora ramorum* and other *Phytophthora* species issues in the S.F. Bay Region

Ft. Ross, Sonoma County, Spring 2018

Photo: Chris Lee, CALFIRE

Susan J. Frankel, USDA Forest Service, Pacific Southwest Research Station
Albany, CA, USA, sfrankel@fs.fed.us

Update on sudden oak death, *Phytophthora ramorum*

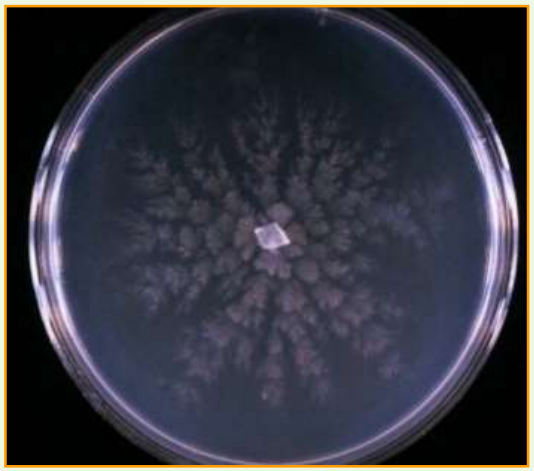
1) A Marin-centric update on sudden oak death

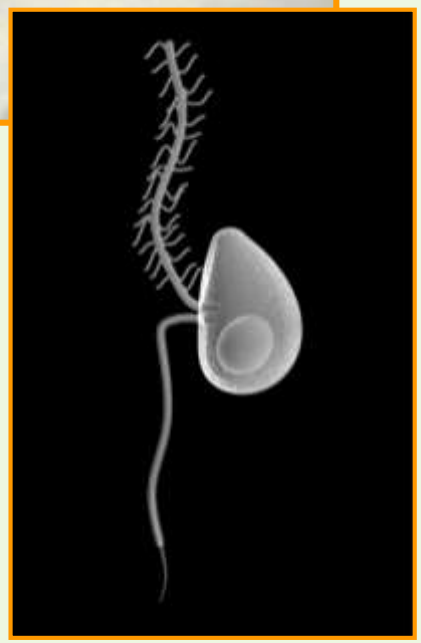
2) Native plant *Phytophthora* concerns - restoration plantings

!!! *Phytophthora* introductions are causing irreversible degradation of forest and wildlands.

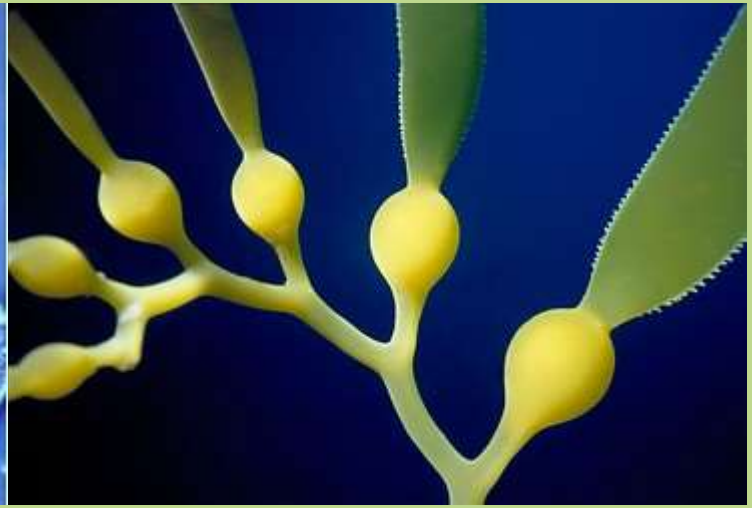
!!! Prevention is key.

What are Phytophthoras?

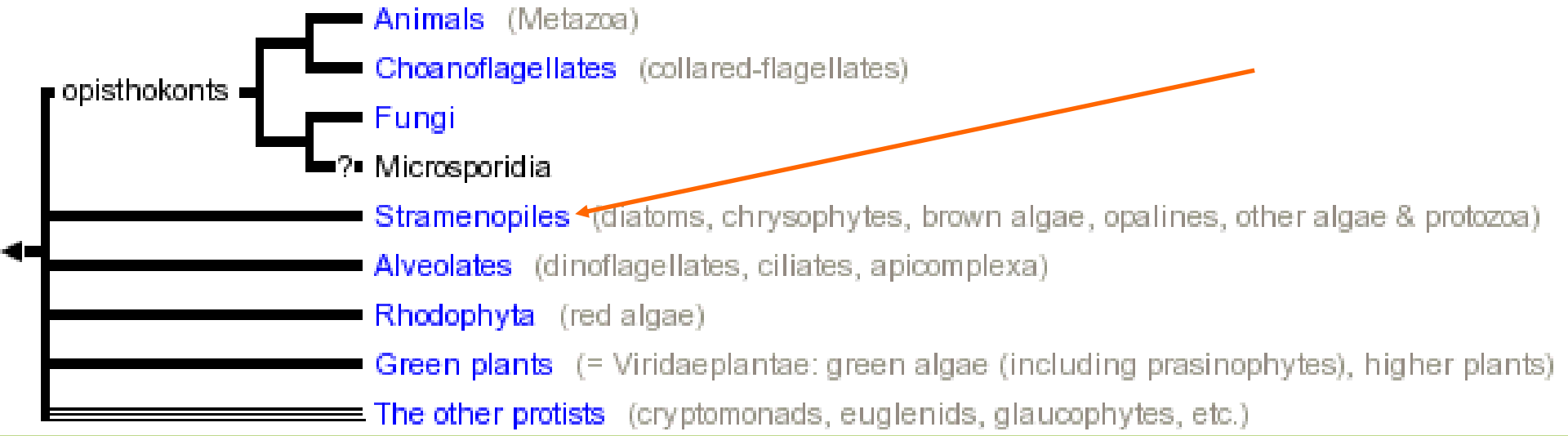




Photographs: Rizzo, UC Davis & Garbelotto, UC Berkeley



BROWN ALGAE and DIATOMS



Sogin, Mitchell L. and Patterson, David J. 1995. Stramenopiles. Version 01 January 1995 (under construction). http://tolweb.org/Stramenopiles/2380/1995.01.01 *in* The Tree of Life Web Project, http://tolweb.org/

Phytophthora ramorum; Sudden oak death

From Santa Cruz to Big Sur

Phytophthora ramorum on Japanese larch, *Larix kaempferi,* in Europe

Sudden oak death, Big Sur, Monterey County, Spring 2018

Credit: Kerry Frangioso, UC-Davis

Sudden oak death inspired “art”

Sudden Oak Death - the Mountain Goats

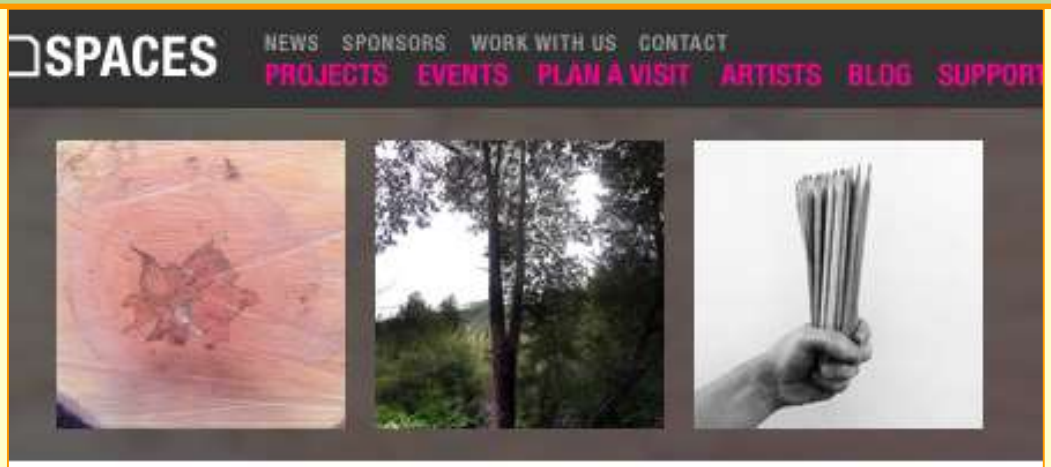
In Stock • Ships tomorrow • 100% Satisfaction

Sudden Oak Death Tee Shirt $24.25 per shirt

“What does it mean to be native to a place, whether human, plant, animal or fungus?”

7000 Marks

Credit: Amber Ginsburg, Spaces, Chicago Institute of Art



7000 Marks

Sara Black & Amber Ginsburg

November 17 - January 12, 2018

Credit: Spaces, Chicago Institute of Art

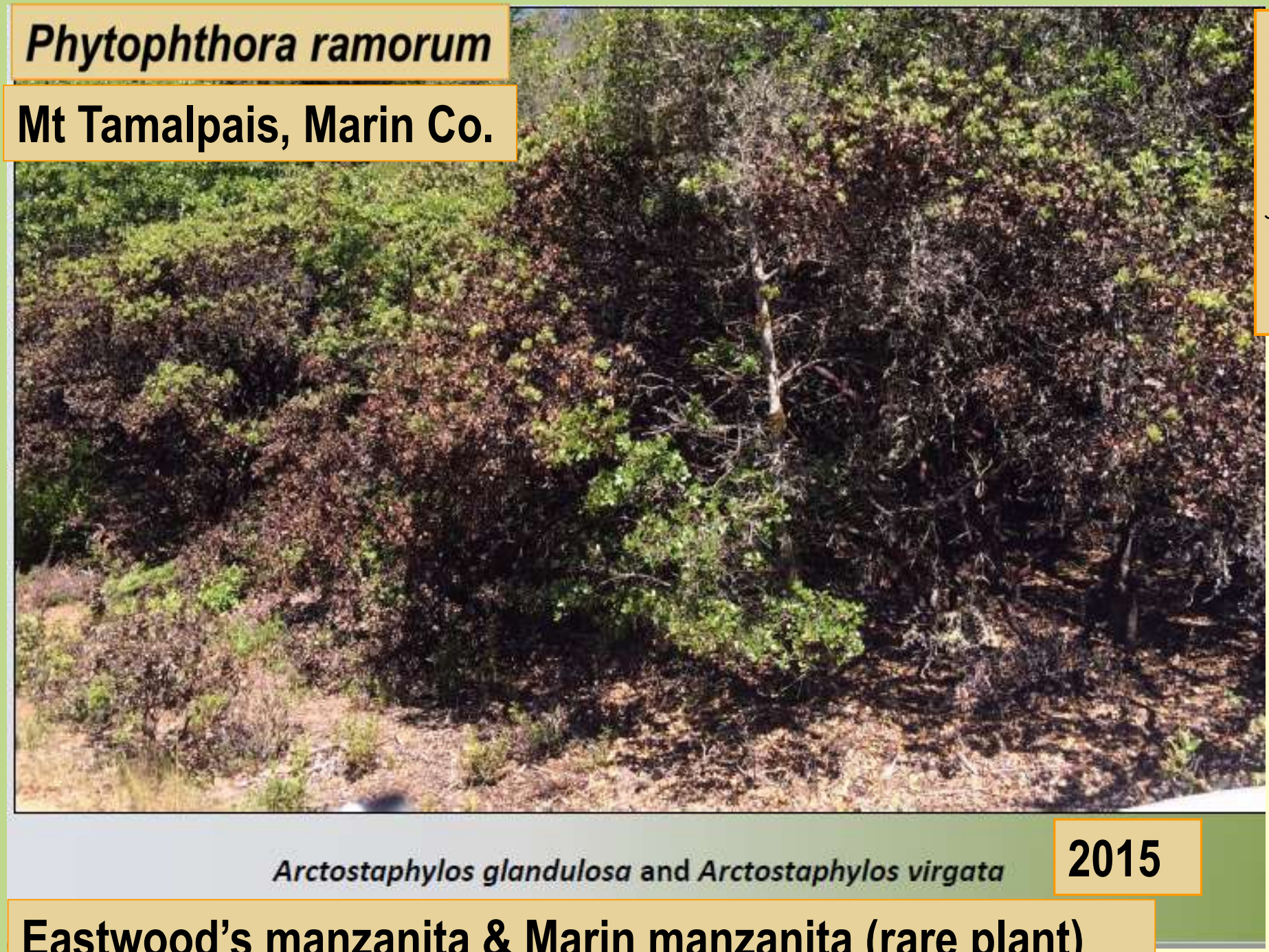
NA1 lineage, tanoak near Brookings, OR

Photo: USFS, PNW FHP

Manzanita – 9 new species as *P. ramorum* hosts

Rainbow manzanita, *Arctostaphylos rainbowenis*

Credit: Latham, CDFA

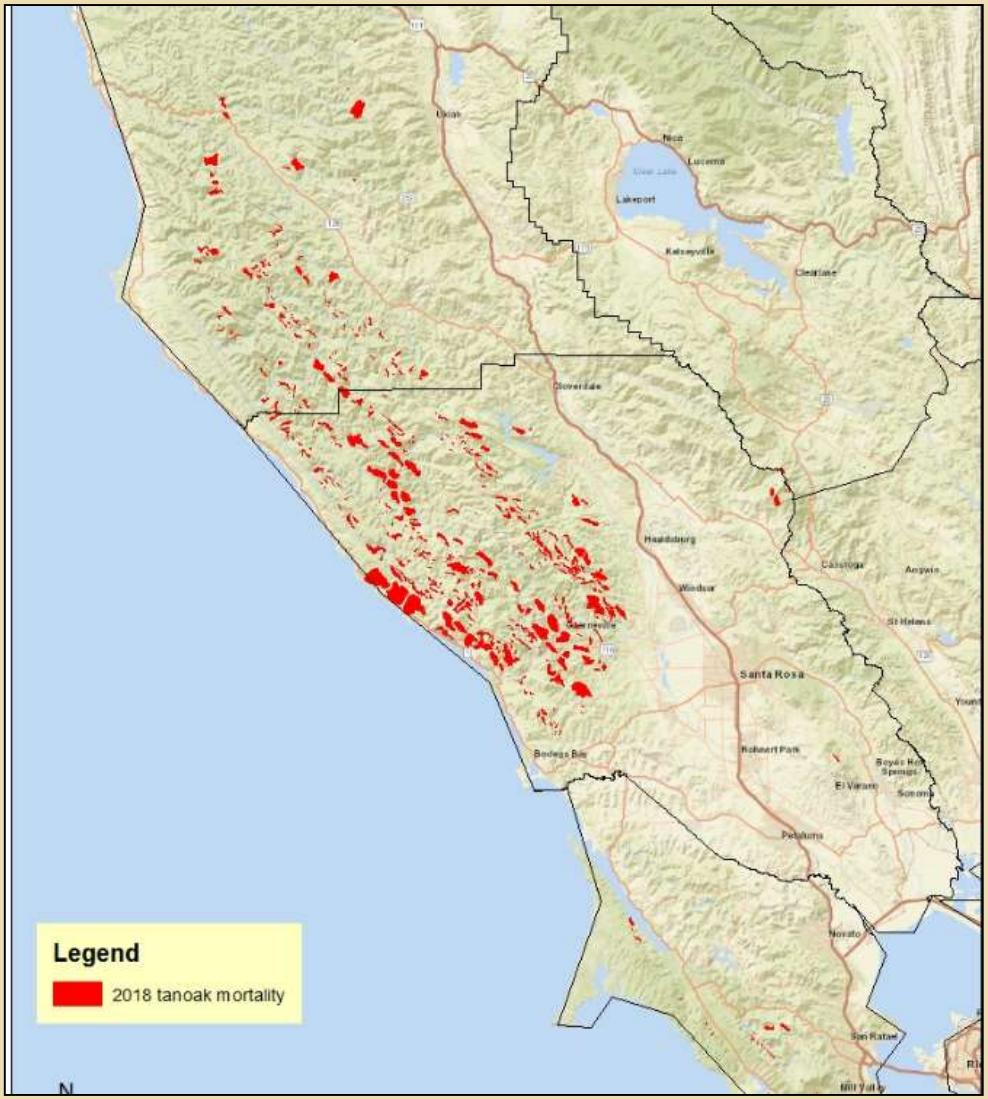

Phytophthora ramorum
Mt Tamalpais, Marin Co.
Credit: Latham,CDFA
Arctostaphylos glandulosa and Arctostaphylos virgata
2015
Eastwood's manzanita & Marin manzanita (rare plant)

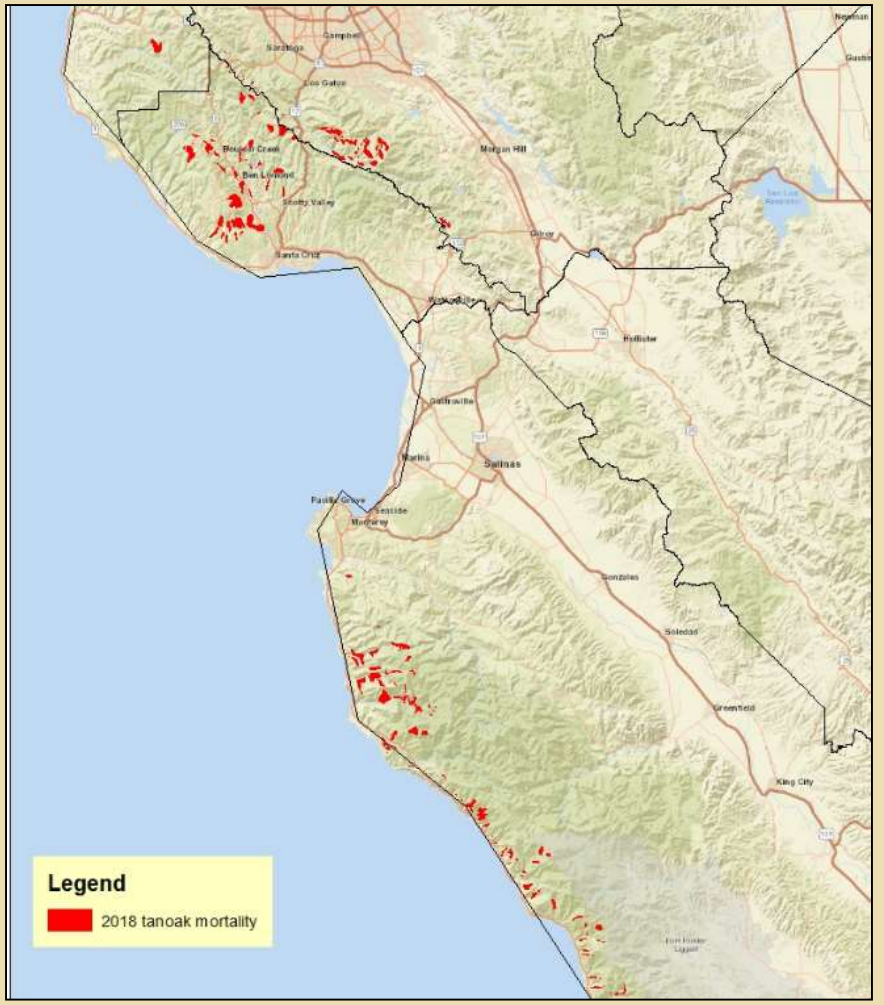
P. ramorum on manzanita, *Arctostaphylos*

Rare plants

Credit: M. Garbelotto, UCB; CALFLORA, Phytosphere

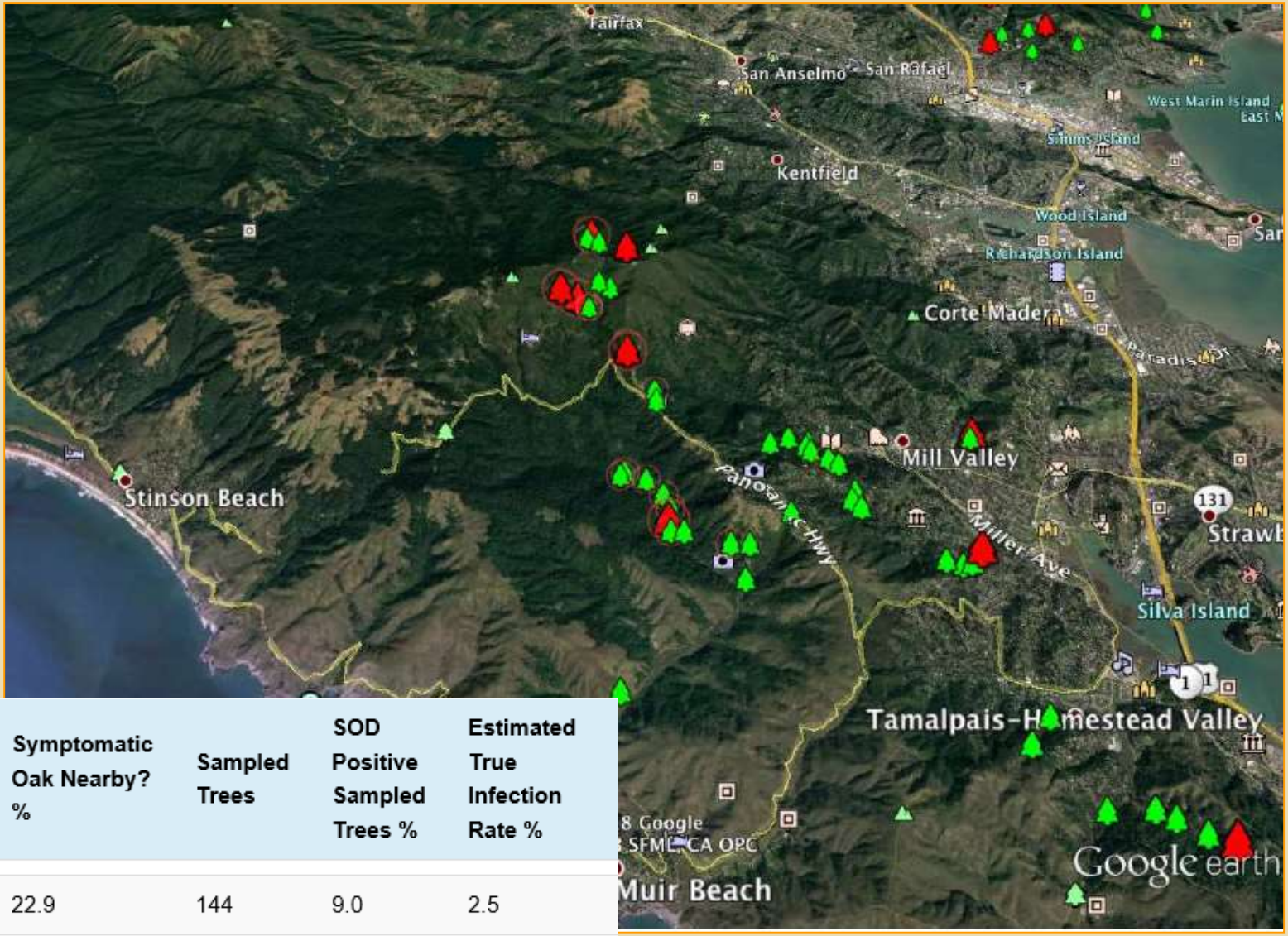
2018 SOD Mortality





Credit: US Forest Service, Pacific Southwest Region, Forest Health Protection, Aerial Survey

Marin County – SOD Blitz 2018 Results



Location	Surveyed Trees	Symptomatic Oak Nearby? %	Sampled Trees	SOD Positive Sampled Trees %	Estimated True Infection Rate %
Marin	1073	22.9	144	9.0	2.5

Credit: Garbelotto, UC-Berkeley

Red = infected

Marin County – SOD Blitz 2018 Results

“Notable outbreaks” in Marin County

Novato,
Day Island,
Woodacre,
Sleepy Hollow,
McNears Beach,
China Camp SP,
North San Rafael,
Tiburon Peninsula,
East and west peak of Mt Tamalpais,
Marin City.

Credit: Garbelotto, UC-Berkeley

Sudden oak death – Mt Tamalpais

Credit: Tomas Pastalka, NORS-DUC

Coast live oak

Credit: Kent Julin; Sonoma County, UCCE, USFS

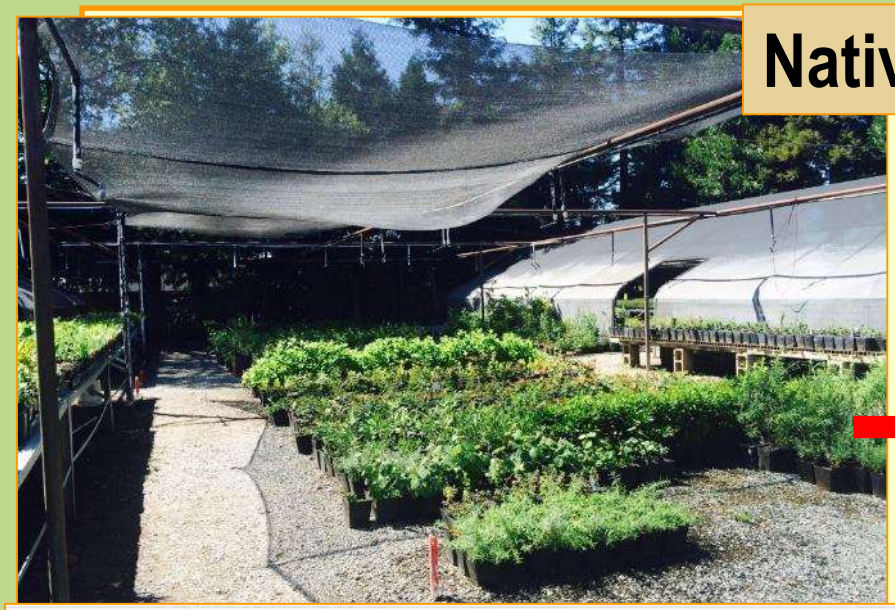
Help!!! Help!!! Help!!! Help!!! Help!!! Help!!! Help!!!

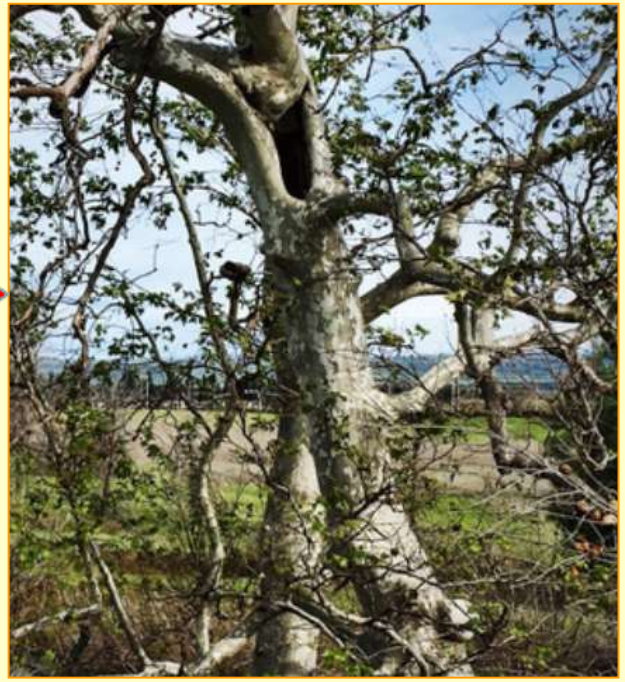
Help!!! Help!!! Help!!! Help!!! Help!!! Help!!! Help!!!

Restoration plantings & hitchhiking *Phytophthoras*

Photos: Phytosphere Research

Native plants, rare plants, restoration





Credit: SFPUC, Phytosphere Research

About the current issue's cover

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SEARCH

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- Plant Health Progress

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Resources

plant disease

Editor-in-Chief: Alison E. Robertson
Published by The American Phytopathological Society

Accepted for publication
https://doi.org/10.1094/PDIS-01-18-0167-RE

Phytophthora species are common on nursery stock grown for restoration and revegetation purposes in California.

Suzanne Rooney-Latham

Cheryl L. Blomquist

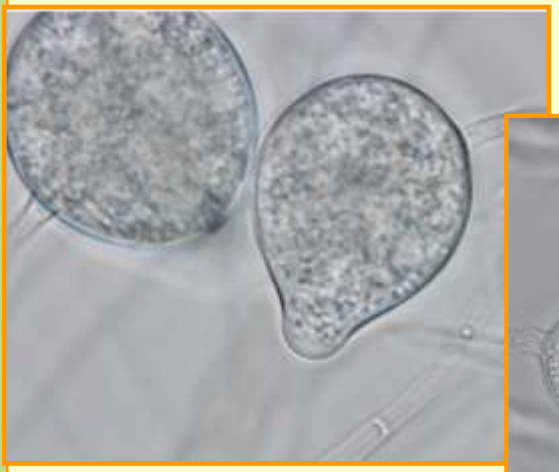
Kathleen L Kosta

Rooney-Latham, S., Blomquist, C.L., Kosta, K.L., and others. 2018. *Phytophthora* species are common on nursery stock grown for restoration and revegetation purposes in California. *Plant Disease*. Early view

Phytophthora quercina

on *Quercus lobata*, valley oak (planted in 2002)

San Jose, CA



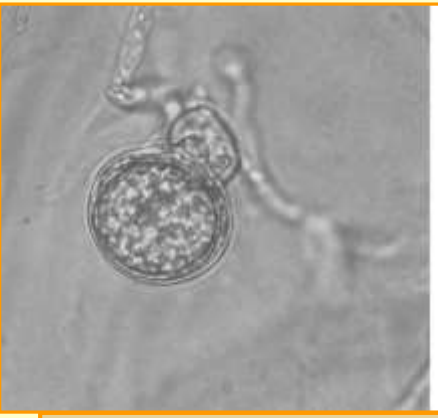
First detection in the USA – 2016

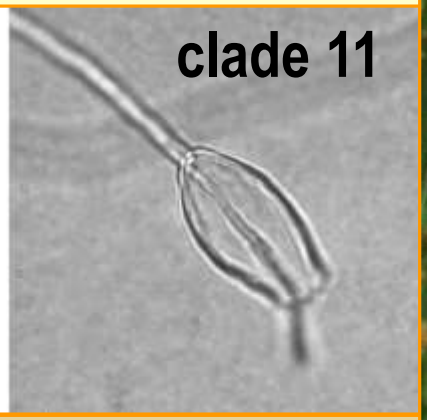
CDFA pest rating - "B"

Credits: Q-bank & Bourret, UC-Davis

P. taxon *mugwort on Artemisia douglasiana*

Santa Clara Valley Water District lands, near San Jose, CA





clade 11

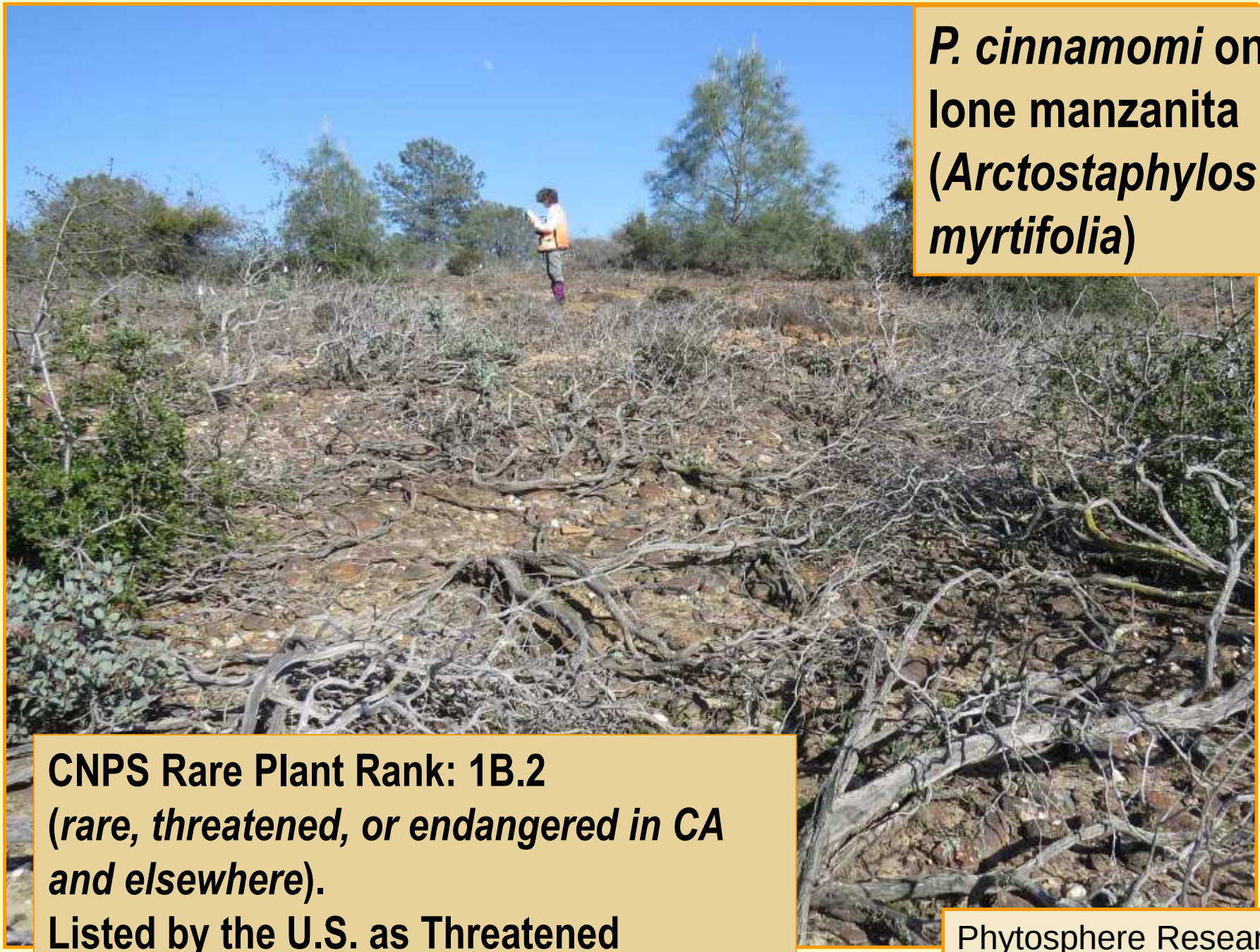
P. taxon *juncus* on *Juncus* species (rush)

Santa Clara Valley Water District lands, near San Jose, CA

Courtesy of Bourret, UC-Davis; Phytosphere Researc

Phytophthora cinnamomi on giant chinquapin (*Chrysolepis chrysophylla*) & pallid manzanita (*Arctostaphylos pallida)* – near Oakland (Alameda Co.)

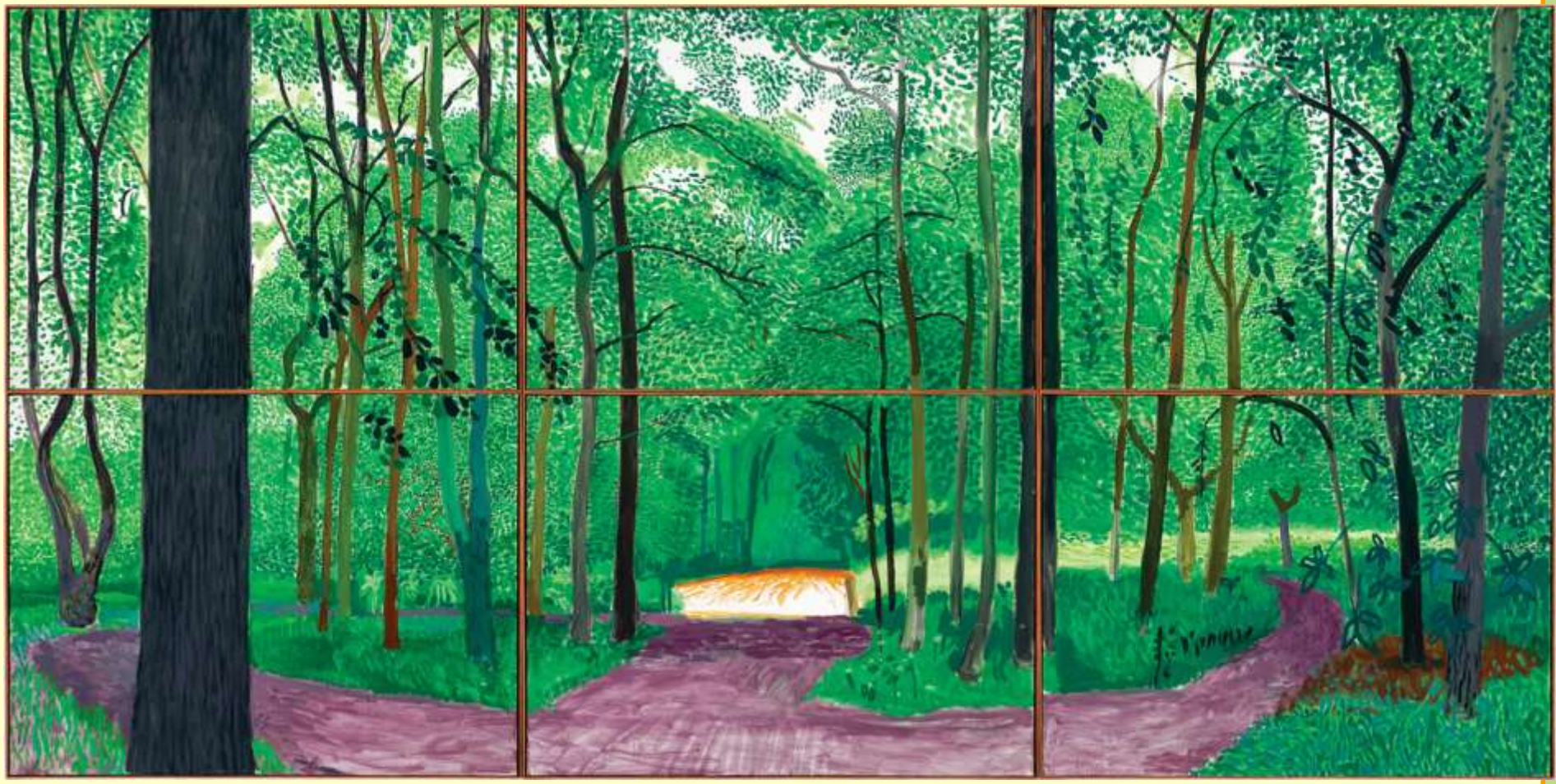
Credit: Phytosphere Research



***P. cinnamomi* on lone manzanita (*Arctostaphylos myrtifolia*)**

CNPS Rare Plant Rank: 1B.2
(*rare, threatened, or endangered in CA and elsewhere*).
Listed by the U.S. as Threatened

Phytosphere Research



David Hockney, DeYoung Museum

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OAK MORTALITY TASK FORCE

Home What is Sudd

Phytophthoras in Native Habitats Work Group

Other Phytophthora species in California's Native Habitats

Several first-in-the-USA detections and newly identified species of *Phytophthora* in both native plant nurseries and restoration areas have occurred in recent years. Many of these *Phytophthora* species appear to have wide host ranges, capable of causing disease on plants across many families and in many different habitats. The **Phytophthoras in Native Habitats Work Group** formed to determine steps needed to protect wildlands and assist the restoration industry. The Work Group is now part of the California Oak Mortality Task Force and serves as an "Other Phytophthoras" committee for that group.

Photo by Janell Hillman, Santa Clara Valley Water District

More information can be found in the following:

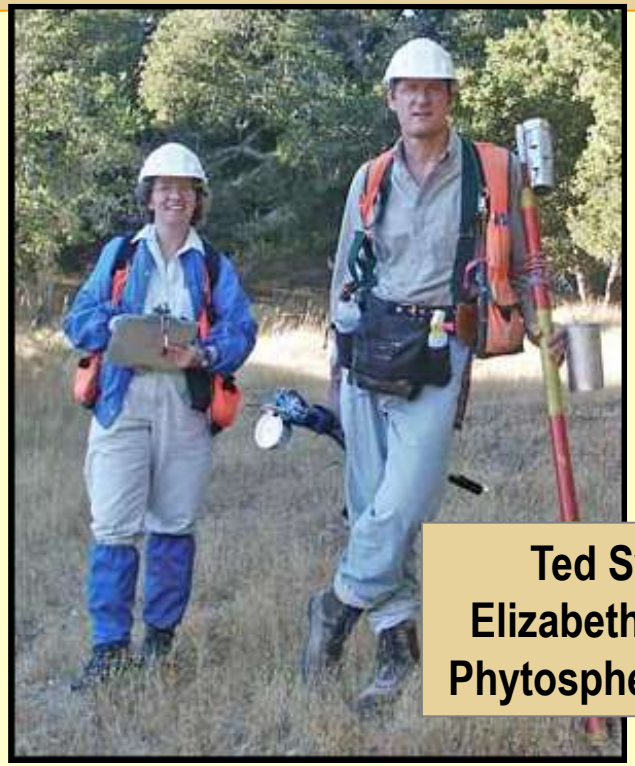
- Background document (February 2017)
- Frequently Asked Questions (February 2017)
- Briefing paper (May 2015)

For more information on Phytophthora species around the world, vis

www.calphytos.org or www.suddenoakdeath.org

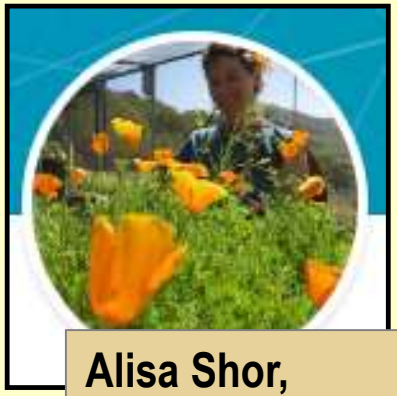
Phytophthoras in Native Habitats Work Group - www.calphytos.org

Tyler Bourret,
UC Davis



Ted Sweicki &
Elizabeth Bernhardt,
Phytosphere Research

Janice Alexander,
UC Cooperative
Extension



Alisa Shor,
Golden Gate NPC

David Rizzo,
UC Davis

Matteo Garbelotto,
UC Berkeley,
Cooperative Extension

Diana Benner,
The Watershed Nursery

California Oak Mortality Task Force

www.suddenoakdeath.org

Look for SOD Blitz results sessions

UC BERKELEY FOREST PATHOLOGY AND MYCOLOGY LAB

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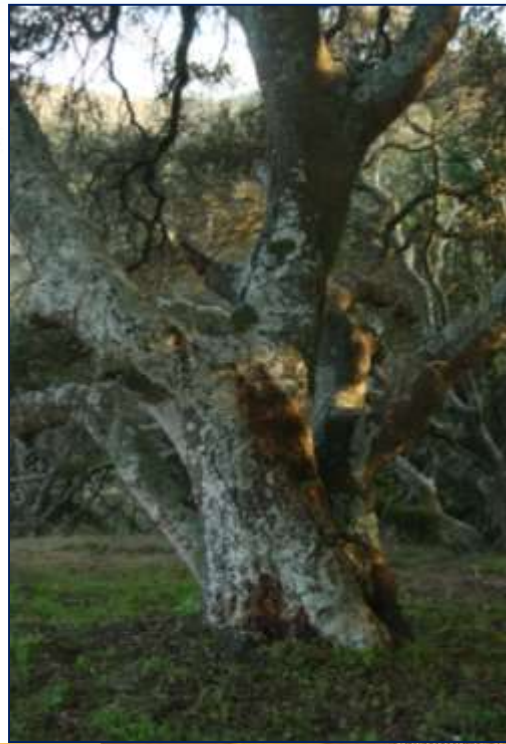
SOD Blitz Meetings Fall 2018

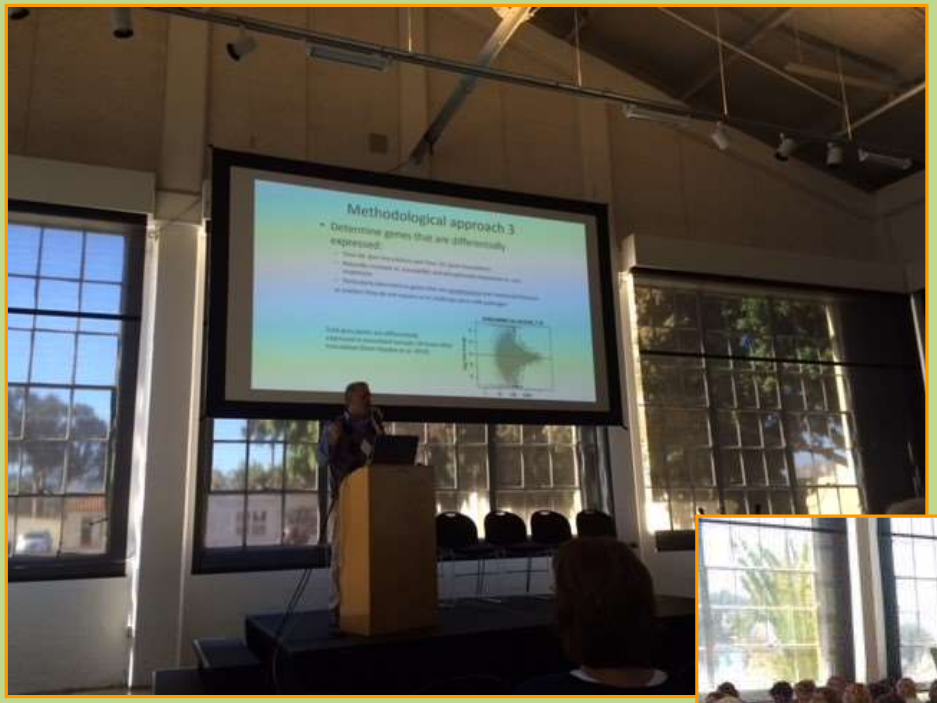
This fall we are offering three workshops where we will discuss the results of the 2018 SOD Blitz, the annual citizen science sudden oak death survey, as well as provide recommendations to protect high-value susceptible oak trees from *Phytophthora ramorum*, the pathogen known to cause sudden oak death. Workshops are open to the general public, tree care professionals, land managers, and other interested parties. CEUs with ISA are pending.

- 10/10/18 Wednesday, 6 pm, UC Cooperative Extension Office, 133 Aviation Blvd., Santa Rosa, CA
- 10/16/18 Tuesday, 7 pm, Portola Valley Town Center, 765 Portola Rd, Portola Valley, CA
- 10/17/18 Wednesday, 7 pm, Morgan Hall Lounge Rm 114 Morgan Hall, UC Berkeley Campus, Berkeley, CA



Mark your calendar…

7th Sudden Oak Death Science & Management Symposium June 25 - 27, 2019. Golden Gate Club, The Presidio.



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David Rizzo and Tyler Bourret, UC-Davis;
Katie VinZant and Janet Nickerman, Angeles National Forest
and many others.

For info on sudden oak death: www.suddenoakdeath.org.
For Phytophthoras on native plants: www.calphytos.org.