Sudden Oak Death

In Review: 2018

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Sudden Oak Death

- Caused by *Phytophthora ramorum*
  - Fungus-like organism
- 2 Diseases
  - Foliar blight (huge host list)
    - Nursery issue
  - SOD (kills oaks, tanoak)
    - Wildland issue
- Spread
  - Local: wind driven rain
  - Distance: people
    - Infected plants
    - Shoes & tires
    - Livestock

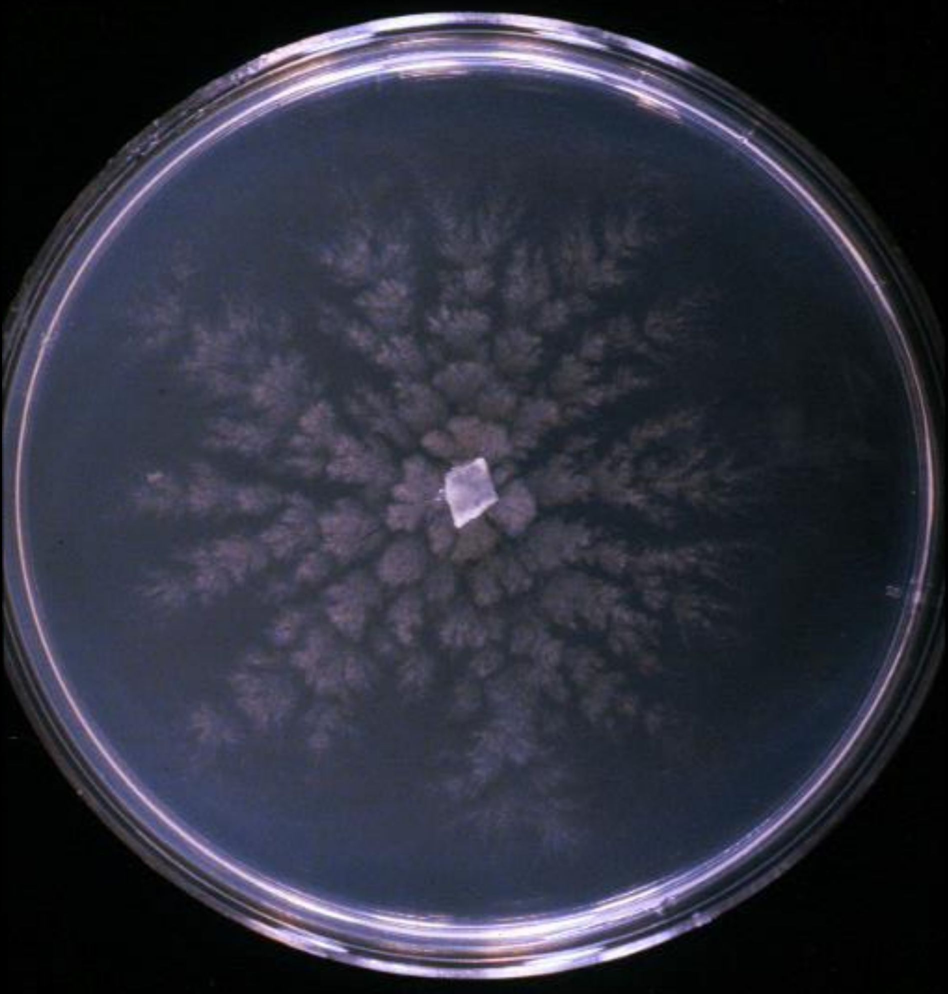
NOT the only Phytophthora

- Irish potato famine
- *Phytophthora infestans*
  - Aerial Phytophthora
- Approximately 1.5m dead
- Another 2m leave
- Germ theory not yet accepted
- Anton DeBary
- Difficult pathogen to control

NOT the only Phytophthora

- Jarrah dieback
- *Phytophthora cinnamomi*
  - Soil Phytophthora
  - Introduced <1940
  - Identification 1965
  - Flood years, wet soil
- *Eucalyptus marginata*
  - Banksia & others
  - 2000 of 9000 species
- Australia has old soils
  - Phosphorous deficient
- AgriFos proven to limit spread
  - Eventually aerially applied

Phytophthora ramorum



Phytophthora ramorum in culture

Sporangia releasing zoospores

Chlamydospores

Impacts

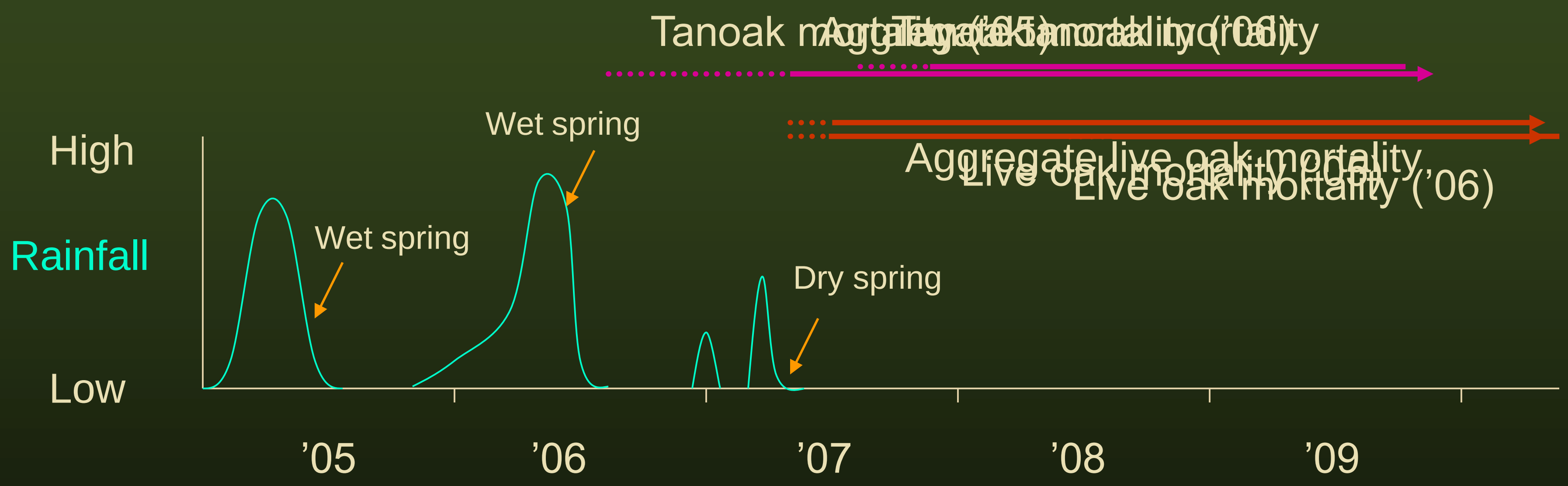
- >1 million trees killed & 1 million currently infected
- 2,000,000+ acres affected
  - < 10% of high risk forest
- Ecology – forests look and act differently, wildlife impacts
- Safety – Hazard trees, fire dangers
- Economics – Costs of mitigation & quarantines, tree removals
- Emotional – individual property owners, recreational users

Impacts

- Fire: No aggregate effect
- Can increase standing dead fuels
  - Which increases fire severity
  - … but only in the worst cases
  - In this case it’s more a question of fuels management

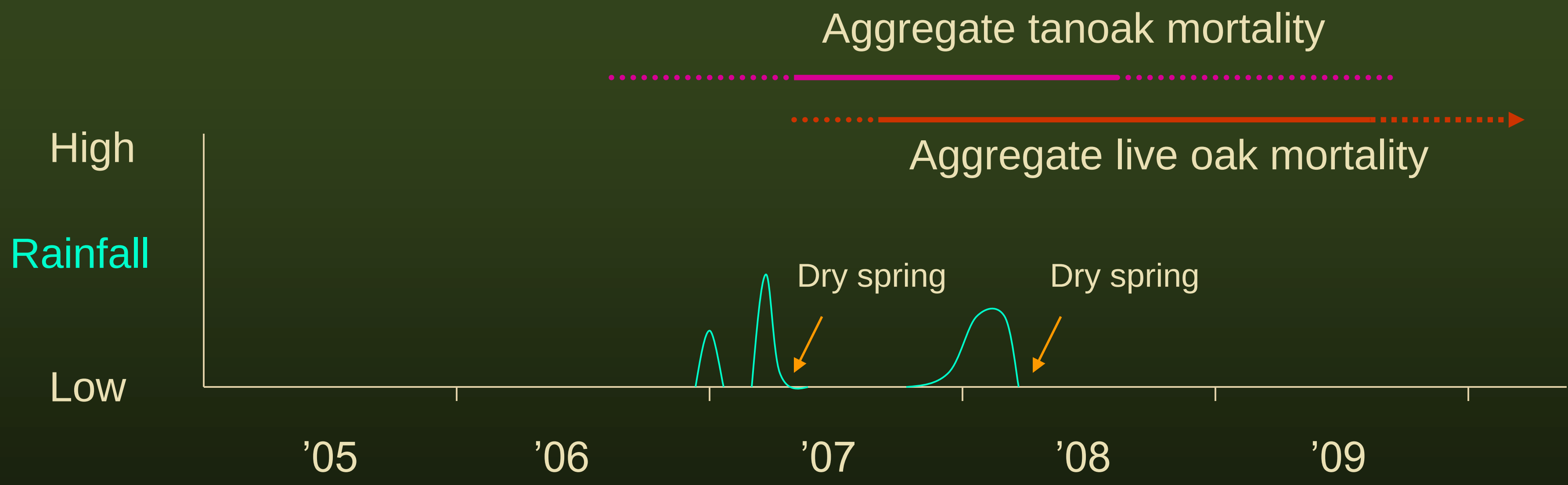
Oak Death Timeline

– Infection:
- Wet springs
- Tanoak mortality: 1-2 years
- Coast live oak mortality: 2-3 years
- Cryptic Infection



Oak Death Timeline

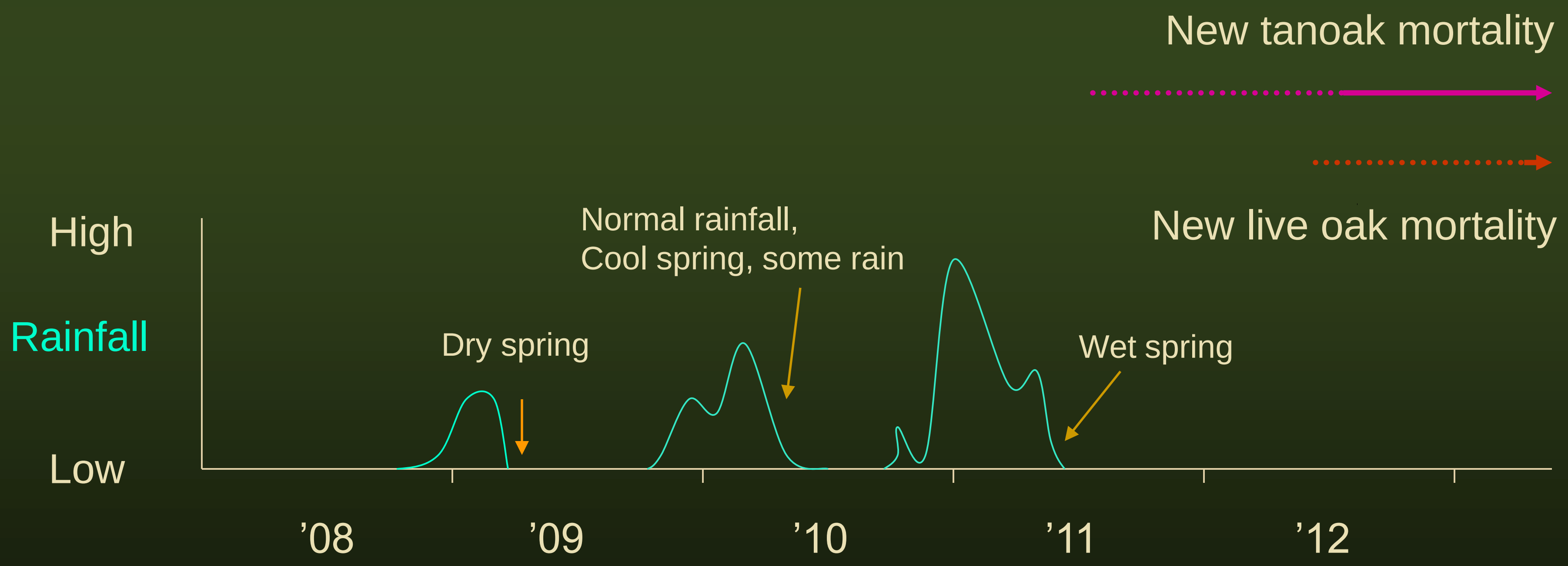
– Mortality rates dropped off after successive dry springs
– Mortality rates increase following wet springs



Oak Death Timeline

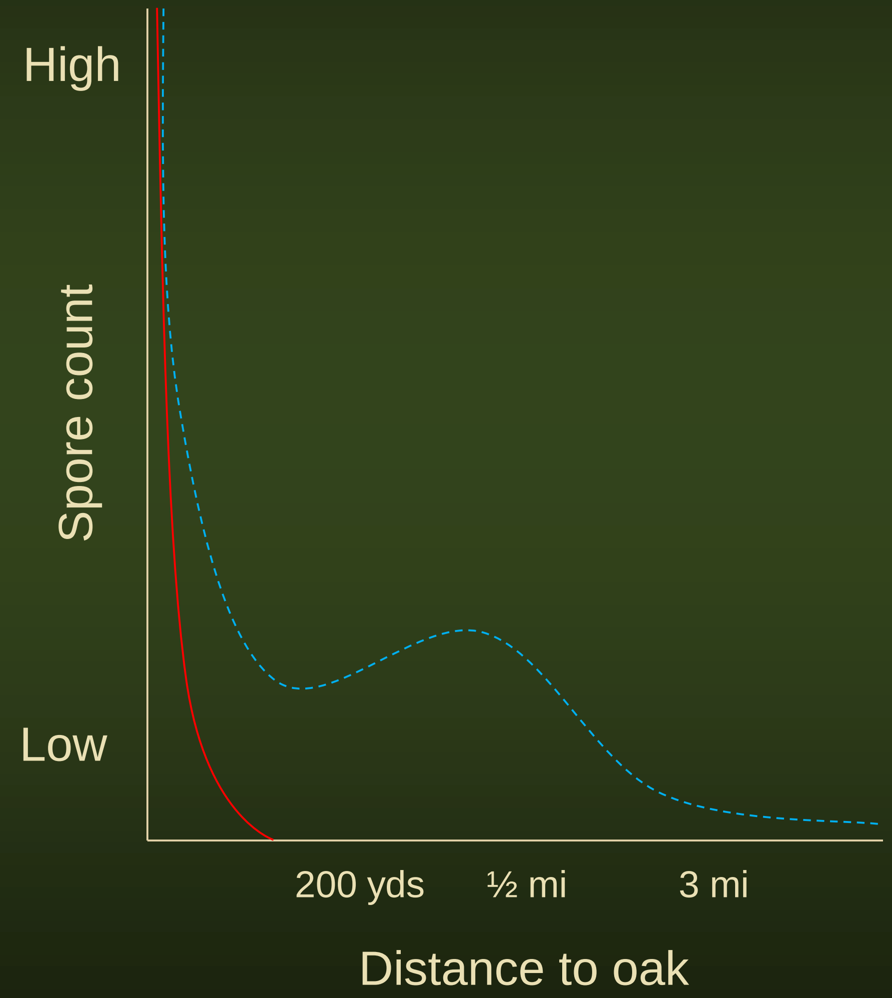
– Mortality rates will drop off with more dry springs

– Mortality rates increase following wet springs



Distance to spore source

- Foliar hosts near true oaks high risk
  - Some risk even at larger distances
- Not as relevant for tanoaks
  - Foliar host itself
  - Self infection



Susceptible Species

>60 Genera; >115 Species/Varieties

Andrew's clintonia bead lily
Anise magnolia
Ardisia
Bay laurel
Bigleaf maple
Blueblossom
California bay laurel
California black oak
California buckeye
California coffeeberry
California hazelnut
California honeysuckle
California maidenhair fern
California nutmeg
California wood fern
Camellia
Camphor tree
Canyon live oak
Cascara
Castanopsis
Chinese gugar tree
Chinese witchhazel
Coast live oak
Coast redwood
Cornus Norman Haddon
Delavay Osmanthus
Douglas-fir
Drooping leucothoe

Eastern joy lotus tree
English laurel
European ash
European beech
European turkey oak
European yew
Evergreen huckleberry
Evergreen maple
False Solomon's seal
Fetterbush
Formosa firethorn
Goat willow
Grand fir
Griselinia
Holly olive
Holm oak
Horse chestnut
Hybrid roses
Hybrid witchhazel
Japanese evergreen oak
Kalmia
Kinnikinnick
Kobus magnolia
Laurustinus
Lilac
Loebner magnolia
Loropetalum
Madrone
Magnolia

Manzanita
Michelia
Mountain laurel
Myrtle-leafed Distylium
Ninebark
Northern red oak
Oleander
Oregon ash
Oregon grape
Oriental holly
Osmanthus
Pacific yew
Persian ironwood
Pieris
Planetree maple
Poison oak
Portuguese laurel cherry
Purple magnolia
Red fir
Red lotus tree
Red tip photinia
Redwood ivy
Rhododendron
Roble beech
Rugosa rose
Salal
Salmonberry
Saucer magnolia
Scotch heather

Scribbly gum
Sessile oak
Sheep laurel
Shreve's oak
Silk tassel tree
Southern magnolia
Southern red oak
Spicebush
Spike winter hazel
Spreading euonymus
Star magnolia
Strawberry tree
Striped bark maple
Sweet bay laurel
Sweet chestnut
Sweet Cicely
Sweet olive
Tanoak
Toyon
Viburnum
Victorian box
Vine maple
Western maidenhair fern
Western starflower
White fir
Winter's bark
Witch hazel
Wood rose
Yew

as of April 17, 2008

"New" additions to the host list

- Lophostemon (= Tristania)
  - Not "typical"
  - Bartlett & CDFA


Image: CDFA, Suzanne Latham

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- 9 species of manzanita (Arctostaphyllos) since 2015
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The big effects

- Nursery contagion
- Tanoak
  - Redwood forest acorns
- True oaks
  - Slower to show symptoms
  - Slower to die
- Resistance
  - Not much in tanoak
  - Some in true oaks

Native Oak biology

- Lynchpin species for our forests
  - Lots of potential pests & pathogens means …
  - Lots of predators or control agents
  - Oaks actively manage pest populations
  - A few pests have the potential to go out of control

Native Oak biology

- Long lived generalists as a group
  - Changes occur over years
- Promiscuous specialists as species
  - Hybrids within sections
  - White oak section
  - Red oak section (new world only)
  - Golden oak section
    - Quercus chrysolepis, canyon live oak

White oaks
(section Quercus)

- *Quercus lobata*
  - valley oak
  - white oak
- *Quercus douglasii*
  - blue oak
- *Quercus garryana*
  - Oregon white oak
  - white oak
- All native trees are oval or lobe leafed and deciduous
- Evergreen scrub oaks
- All immune to SOD

Red (black) oaks

(Section Lobatae)

- *Quercus agrifolia*
  - Coast live oak
- *Quercus kelloggii*
  - Black oak
- *Quercus wislizeni*
  - Interior live oak
- *Quercus parvula*
  - Shreve oak
- Hybrids
- All native trees are either evergreen or have pointed lobes
- All may get SOD
  - Some resistant

Preventative treatment

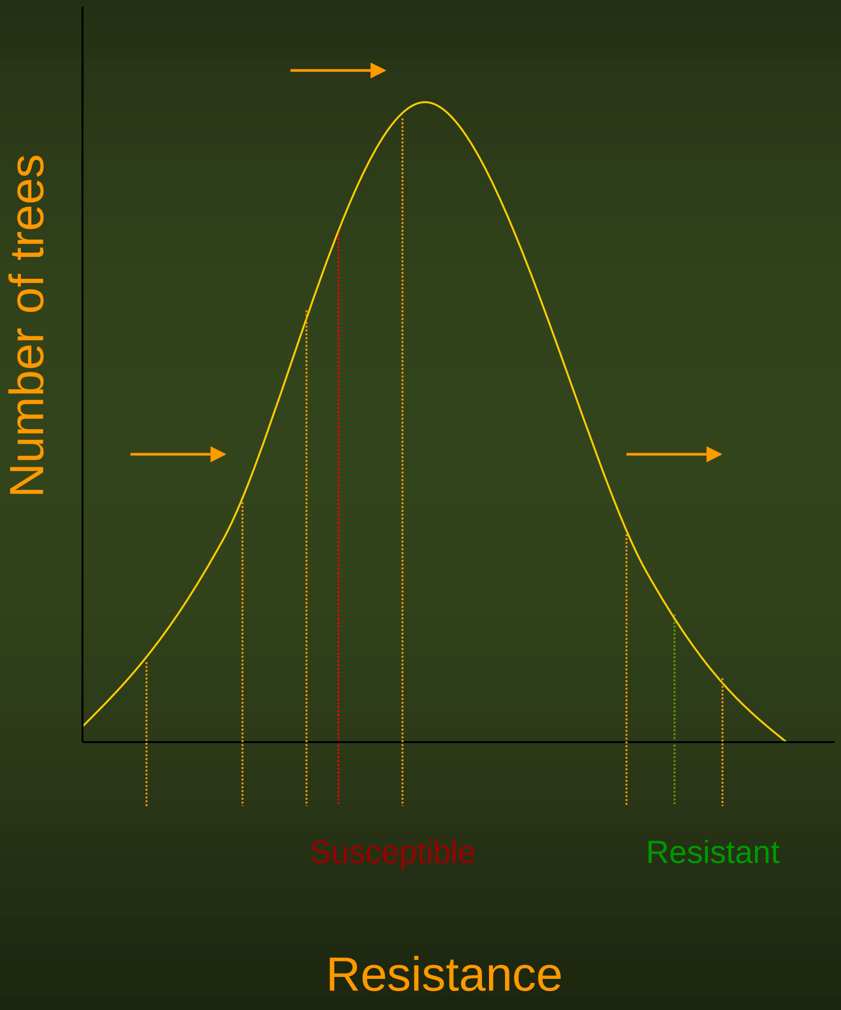
- Phosphonate (AgriFos, Reliant)
  - Injectable
    - Higher dosage
    - Wounds tree
    - Slow application
  - Surface application
    - Lower dosage
    - Simple application
    - Moss burn
      - Understory leaf burn
  - Specimen trees
  - Takes time to work
  - Inhibits fungal growth and activates the plant’s own natural defensive response

Application timing

- Changes over time as we learn more
- Currently:
  - Spring and fall
  - First two
    - 6 months apart
  - All subsequent
    - 12 months apart
- Flexibility
- Variables:
  - Application technique
  - Tree size (age)
  - Inherent resistance

Phosphonate Efficacy

- Anna Conrad
  - Ohio State Universtiy
  - Genetic Markers for Resistance
  - ~ 16% at top end?
- Laboratory results in 2003 promising
  - Subject to interpretation
- Field effectiveness more equivocal
  - Some trees die even after years of prophylactic treatment
- Many “alternative” treatments are simply ineffective
- Still used largely due to lack of more effective treatment



Phosphonate limits

- Helps bolster tree's natural defenses
  - Weak tree = weak effect
- Better as prophylactic
  - Not great curative
  - Treat ahead of time
- Useless on infected tanoaks
  - Cryptic infection

Not the only option

- Some oaks already resistant
- Continual re-infection from nearby bay laurels means they eventually succumb
- Removal of bays may help these oaks survive

Bay laurel thinning / removal

Before

After

Images: Yana Valachovic

“Alternative” treatments

- Forest decline claim
- Soil acidification claim
  - Acid rain
  - Mosses and lichens
- No scientific data
- Probably won’t hurt anything
  - Soil test?

Bark scribing

- Scribing alone is ineffective
  - Oaks kill *P. ramorum* ***most of the time***
  - Practitioners take credit for the oaks' work

Hazard trees

- No target? No hazard
- Hazard warnings:
  - *Annulohypoxylon*
    - Sapwood decay
  - Ambrosia beetle
    - Gallery builder
      - Tan frass in cracks
    - *Ambrosiella* fungus
  - Native organisms
    - Failure when still green

Disposal

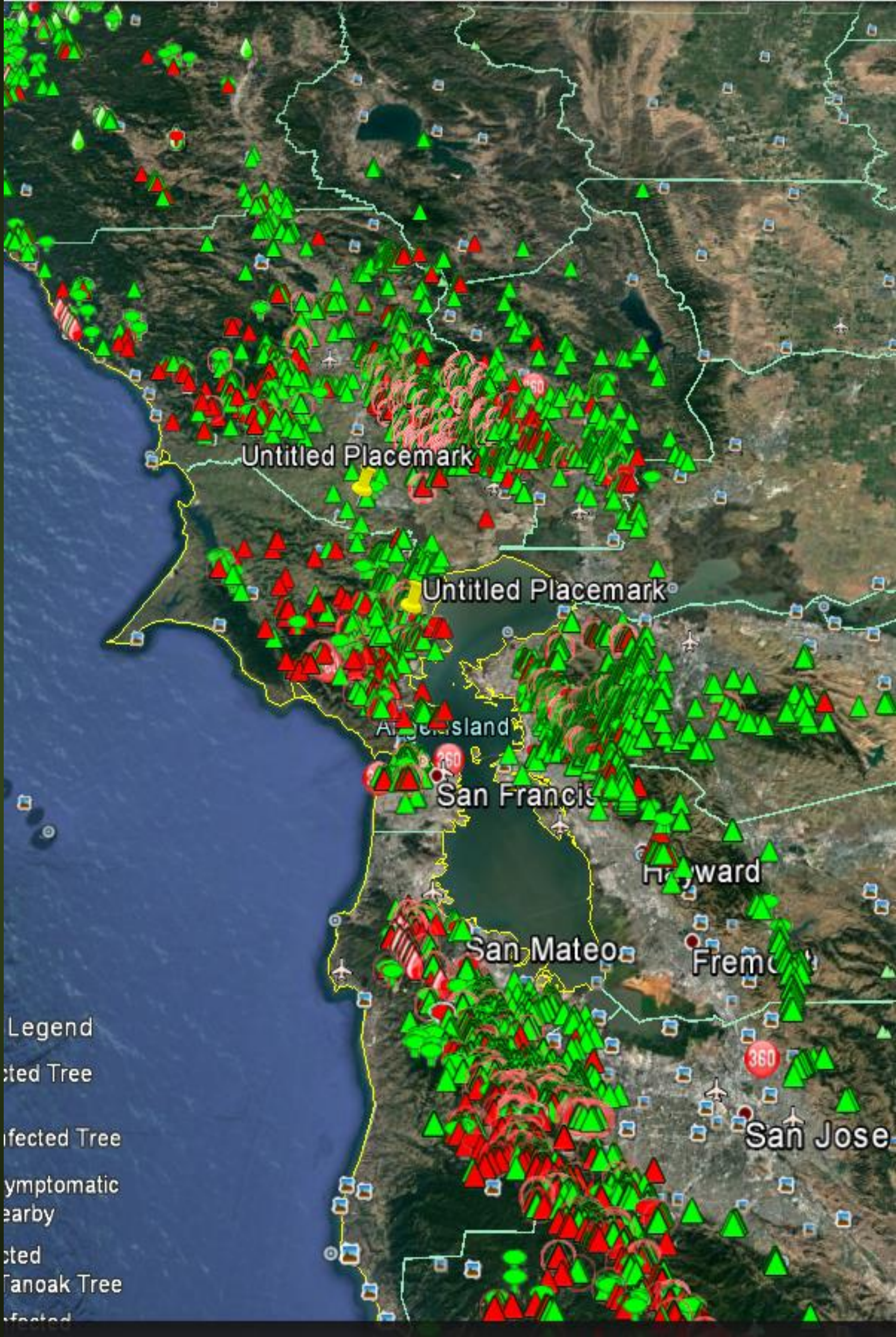
- Quarantine
  - Don’t move infected material out of county
- Best left on site
  - Wrap cut wood in clear plastic?
  - Lop brush to ground
- Composting kills the pathogen
- Landfills and compost facilities in compliance

Oak Mortality

- Follows wet springs
  - 1 to 3 year symptom lag
- AgriFos
  - Preventative
  - Efficacy not assured
- Laurel removal
- Hazard oaks?
  - Beetles/Hypoxylon
  - Consider removal
- Disposal
  - Keep on site
  - Compost

Diagnosis

- Does it look like SOD?
- Is it on a known host?
  - Foliar host?
  - Branch host?
  - Terminal host?
- Is it in the infected area?
  - https://nature.berkeley.edu/garbelottowp/?page_id=755
  - Yes? Call it SOD.
  - No? Get it tested.



Resources

- Sudden Oak Death website: www.suddenoakdeath.org
- Sodmap: https://nature.berkeley.edu/garbelottowp/?page_id=755

- Metz, M. et al. (2013) Unexpected Redwood Mortality from Synergies Between Wildfire and Emerging Infectious Disease. *Ecology* 94:2152–2159 http://dx.doi.org/10.1890/13-0915.1
- Metz, M. et al. (2011) Interacting Disturbances: Wildfire Severity Affected by Stage of Forest Disease Invasion. *Ecological Applications* 21(2):313-320 http://www.esajournals.org/doi/pdf/10.1890/10-0419.1
- Beh, M. et al. (2012) The Key Host for an Invasive Forest Pathogen Also Facilitates the Pathogen's Survival of Wildfire in California Forests http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.2012.04352.x/abstract

- CalFire clearances: http://www.calfire.ca.gov/communications/downloads/fact_sheets/DefensibleSpaceFlyer.pdf

- This presentation is on line at: http://ucanr.edu/MarinIPM

- Steven Swain: svswain@ucanr.edu

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Bark scribing

- Scribing alone is ineffective
  - Oaks kill *P. ramorum* ***most of the time***
  - Practitioners take credit for the oaks' work
- Takao Kasuga
  - Rizzo Lab, UC Davis
  - Loss of fitness when infecting oak

Presidio find

- No bays anywhere close
- Toyons quite close
- Genetic fingerprint matches nursery type, not wild type
  - Neighbor across street had infected landscape plants in 05 & 06
  - Rain years!
- Suggests strict focus on bay trees might be a little myopic

What if they're already dying?

- Evaluation
  - Hazard
  - Fire
- Removal plan
  - Not always necessary
- Reforestation
  - Right tree, right place

Mono and Di Potassium Salts of Phosphorous Acid

- Shorthand: Phosphonate
- Trade Names: AgriFos, Reliant, others
- Signal word: caution
- Generally used for oomycete pathogens
  - Efficacy on wide variety of plants
    - Eucalyptus trees
    - Broccoli (outside of California)
  - California different
    - SOD only oomycete allowed
    - Fusarium and Venturia allowed
      - Efficacy data on Fusarium deeply flawed