

Phytophthora ramorum



Sudden Oak Death
Santa Cruz Mountains, CA.
1999

Phytophthora ramorum Discovered in a California Nursery



December, 2000

Again, March, 2002



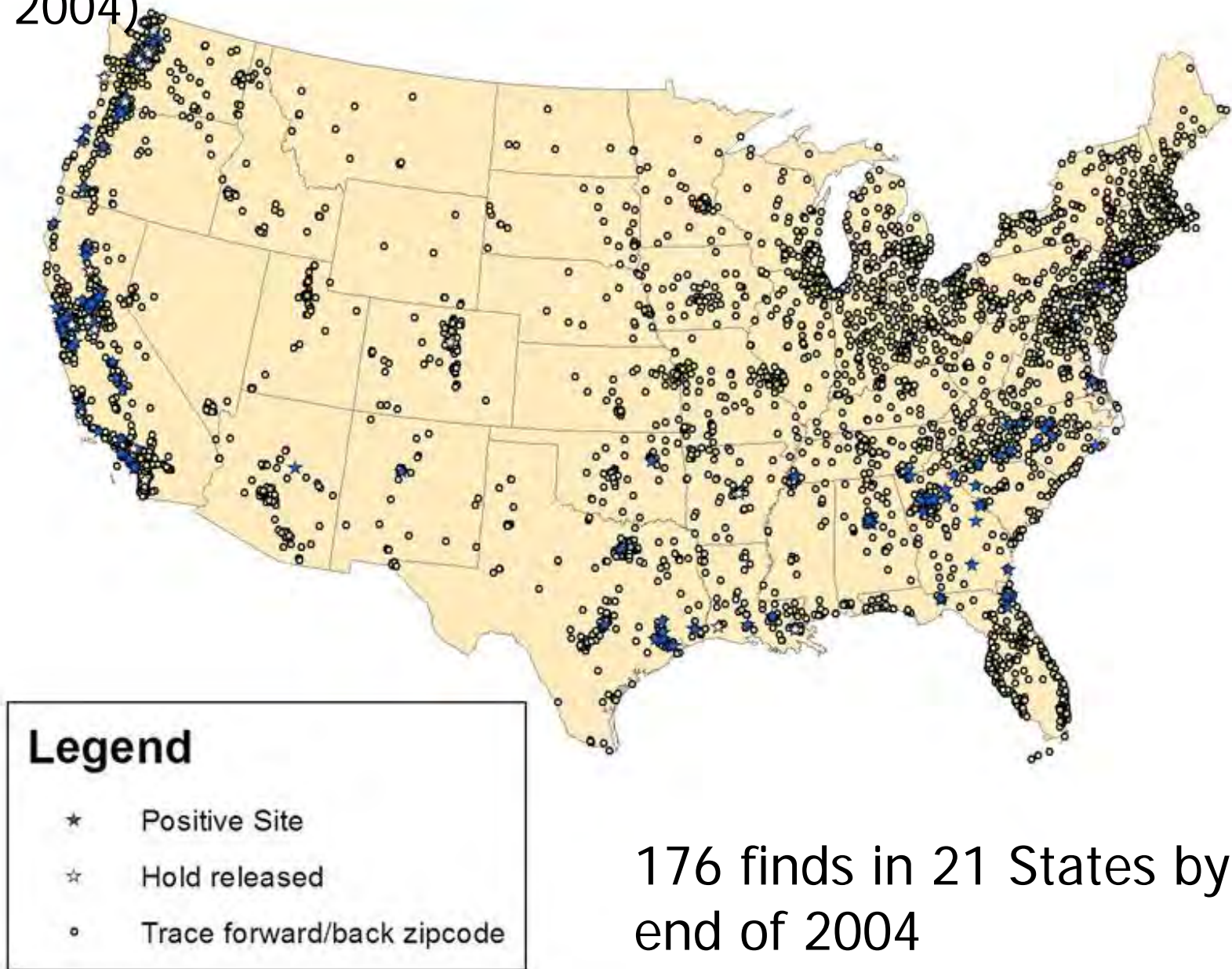
Phytophthora ramorum

in more nurseries

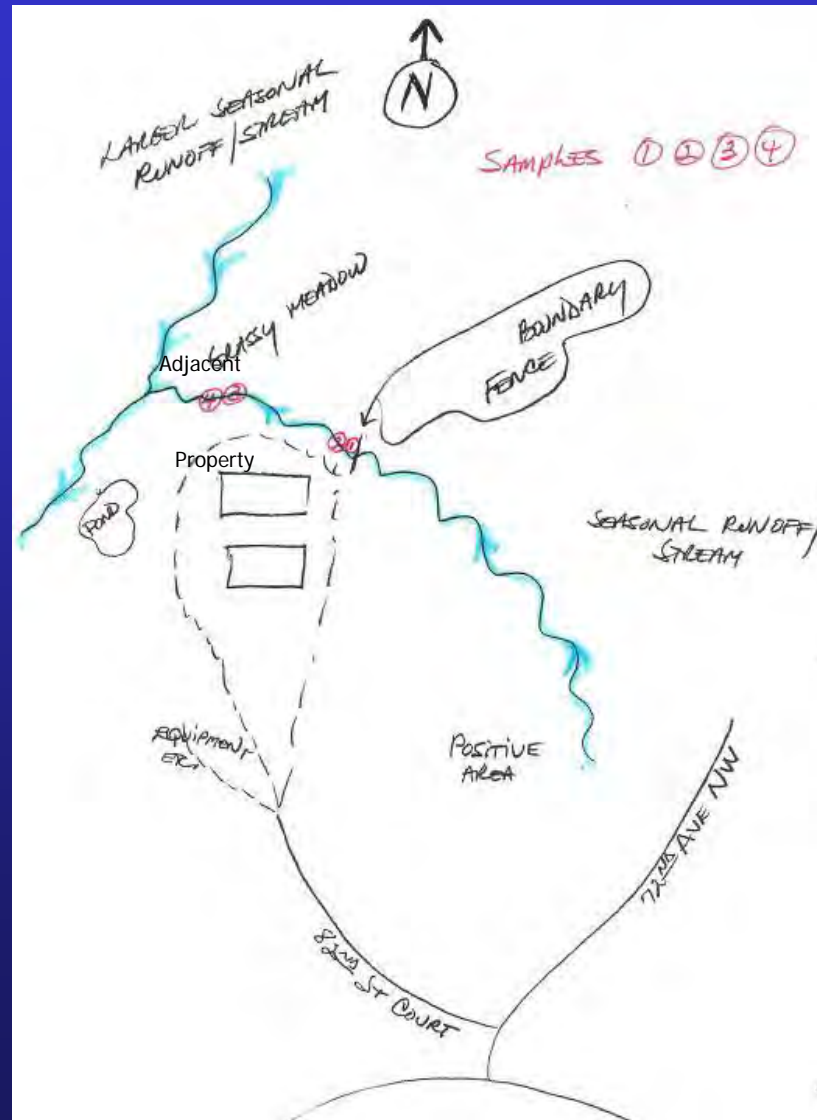


February 2004, Azusa CA., Camellia

Trace-forwards and positive detections across the U.S. (July 2004)



Recovery of *P. ramorum* downstream from an infested Washington nursery



Management in Nursery

Preventing Introduction and Persistence

1. Inspection of plant introductions and nursery scouting
 - Know hosts and host symptoms
 - Know the source (CDFA lists nurseries under compliance agreements)

Ornamental hosts

- *Rhododendron*, *Camellia*, *Pieris*, *Viburnum*, *Kalmia latifolia* (USA)
- Genera listed above and *Syringa*, *Leucothoe fontanesiana*, *Arbutus unedo*, *Pittosporum undulatum*, *Magnolia*, *Photinia*, and others (EU)
- *Rhododendron*, *Euonymus*, *Gaultheria*, *Osmanthus*, and *Prunus*. (Canada)
- Native species used in ornamental landscape (redwood, madrone, manzanita, etc.) (CA., OR.)
- Christmas tree farms (*Pseudotsuga menziesii*, *Abies concolor*, *Abies grandis*) (CA)

Plant diseases associated with *P. ramorum*



Host Symptom Examples



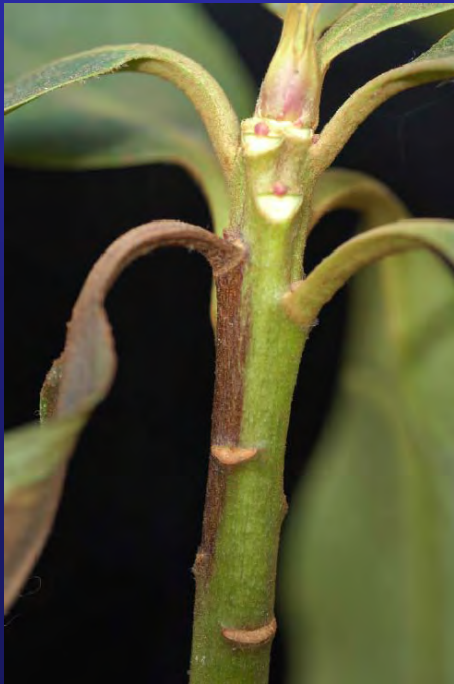
Rhododendron



Camellia



Pieris



Viburnum



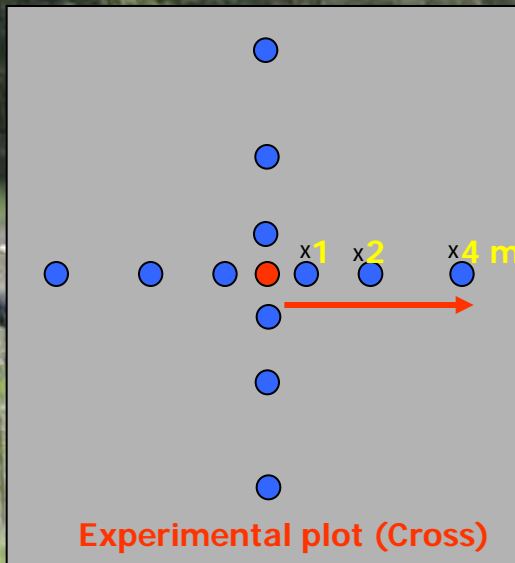
Management in Nursery

Preventing Introduction and Persistence

2. Cultural practices to prevent movement and persistence within nursery

- Air
- Water
- Soil and Plant Debris

Aerial Dispersal



Dispersal within Plant Block

2004-2005 Season 1/24/2005



Central Inoculated plant
10 inoculated leaves



Number of infected leaves in all 5 replicated blocks



2003, Marin County

California Bay is a common host surrounding some nurseries

Water Dispersal

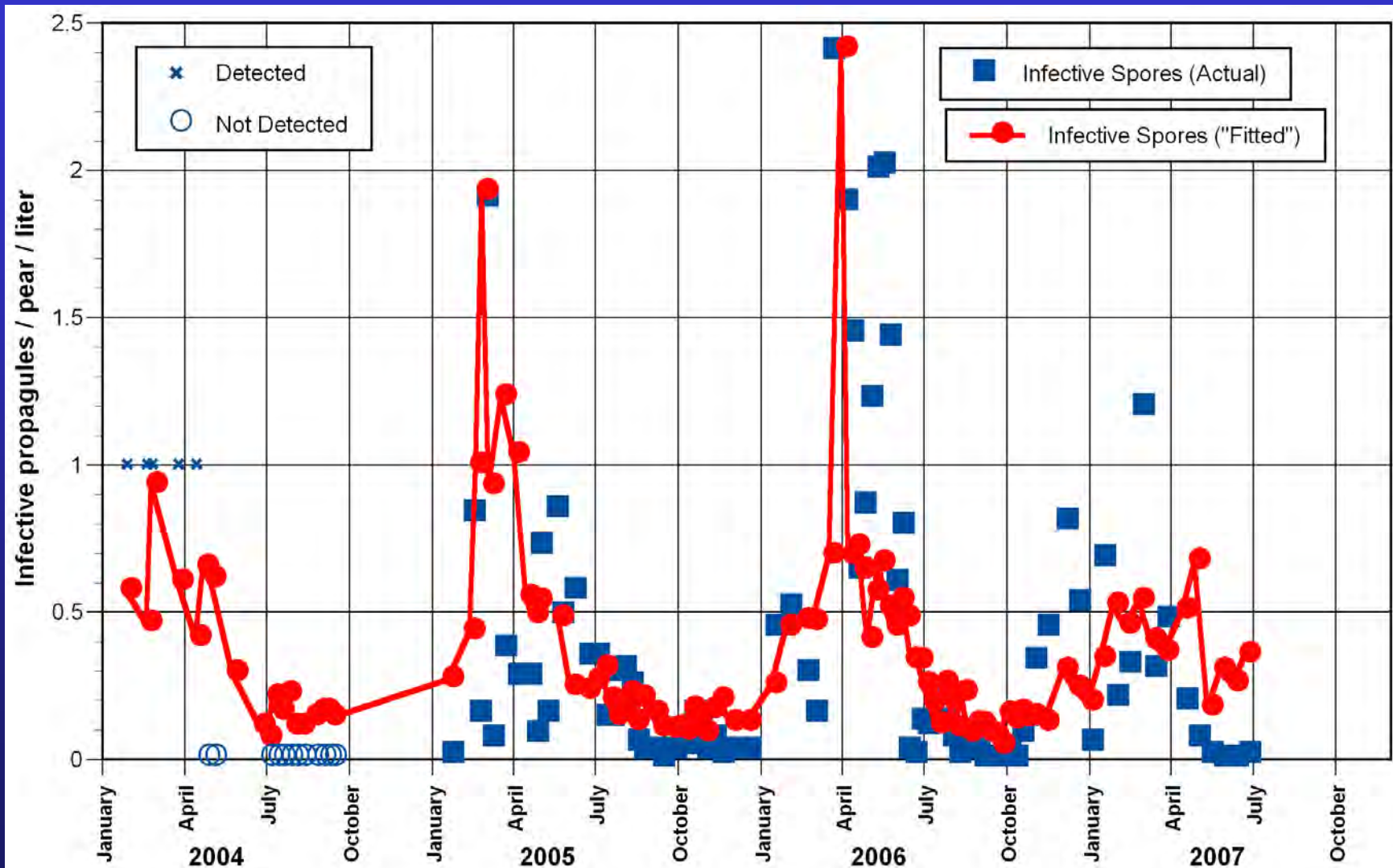
Incidence of *P. ramorum* Isolated From Rivers And Streams In Santa Cruz County, CA. 2001-02

Sample Source	04/09/01	09/18/01	01/04/02	01/31/02	02/08/02	02/19/02	02/28/02	03/10/02	03/19/02	03/25/02	Total
Bean Creek	+		+		+		+	+	+	+	7
Soquel Creek						+		+		+	3
Lompico Creek					+	+		+			3
Aptos Creek											0
San Lorenzo River		+				+	+	+	+	+	6
Branciforte Creek			+	+	+	+					4
Corralitos Creek											0
Total	1	1	2	1	2	4	2	5	2	3	23

Seasonal stream concentration of *P. ramorum* in Santa Cruz Co.

$$P. \text{ ramorum concentration} = e^{4.8 + 0.049 \text{ Rain} - 0.15 \text{ max Temp}}$$

Rain = mm (4 day prior to sampling)
max Temp = °C (65 day prior)



Irrigation with Stream and City Water

2004-2007 (4 annual experiments)

Experimental treatments

1. City Water/ Drip
2. City Water/ Sprinkler
3. Stream Water/ Drip
4. Stream Water / Sprinkler



Disease detected only 3 times on plants sprinkler irrigated with stream water:

22 Apr 2005
12 May 2006
23 Jun 2006

<u>Experimental Layout</u>				
22 Apr 2005				
1				4
2				
3				24
4				
5	32			
6				32

of necrotic lesions on multiple plants



Movement in water within a nursery and/or recycled water



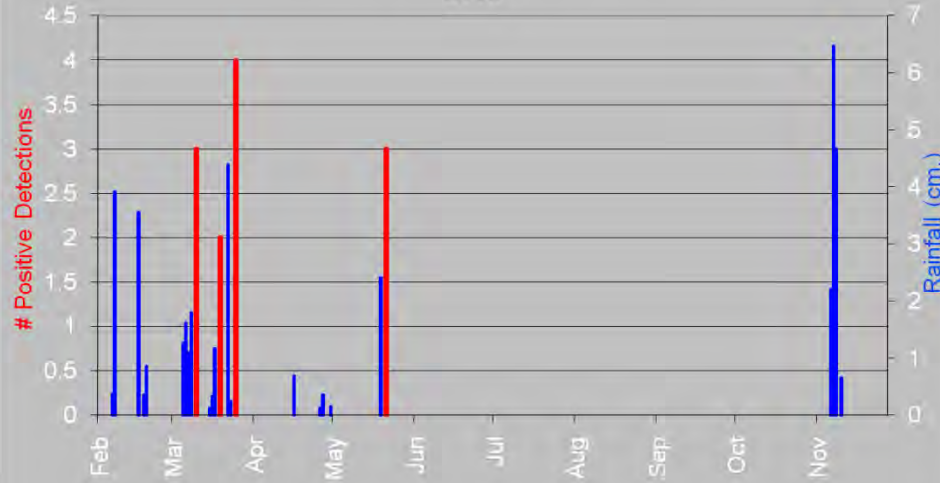
Importance of Rainfall and Sprinkler Irrigation in Supporting Sporulation and Spread in Water Runoff

2006-2008

- **Rainfall** is most effective in producing conditions for foliar sporulation and inoculum in runoff.
- **Sprinkler irrigation** can also be effective.
- **Leaf wetness hours** affects the concentration of inoculum during event.
- **Foliar disease** can result from runoff water.
- **Root disease** can result from runoff.

Soil Dispersal

Trail: Detection vs. Rainfall
2002

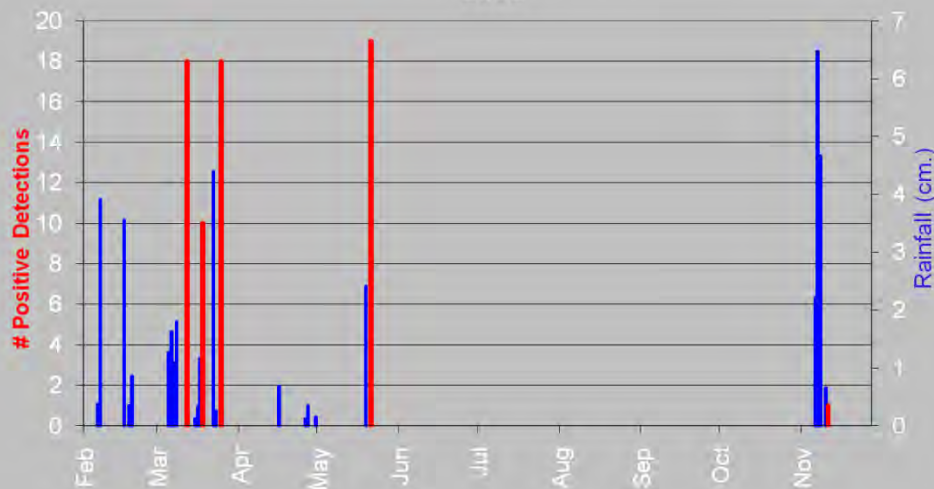


Hiking
shoes
infested



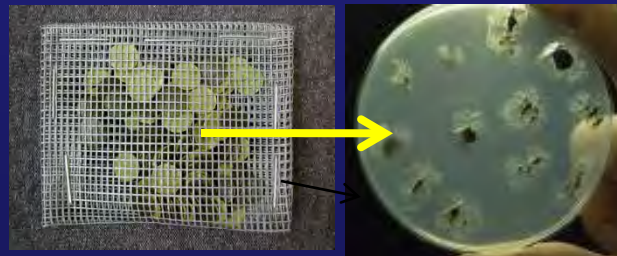
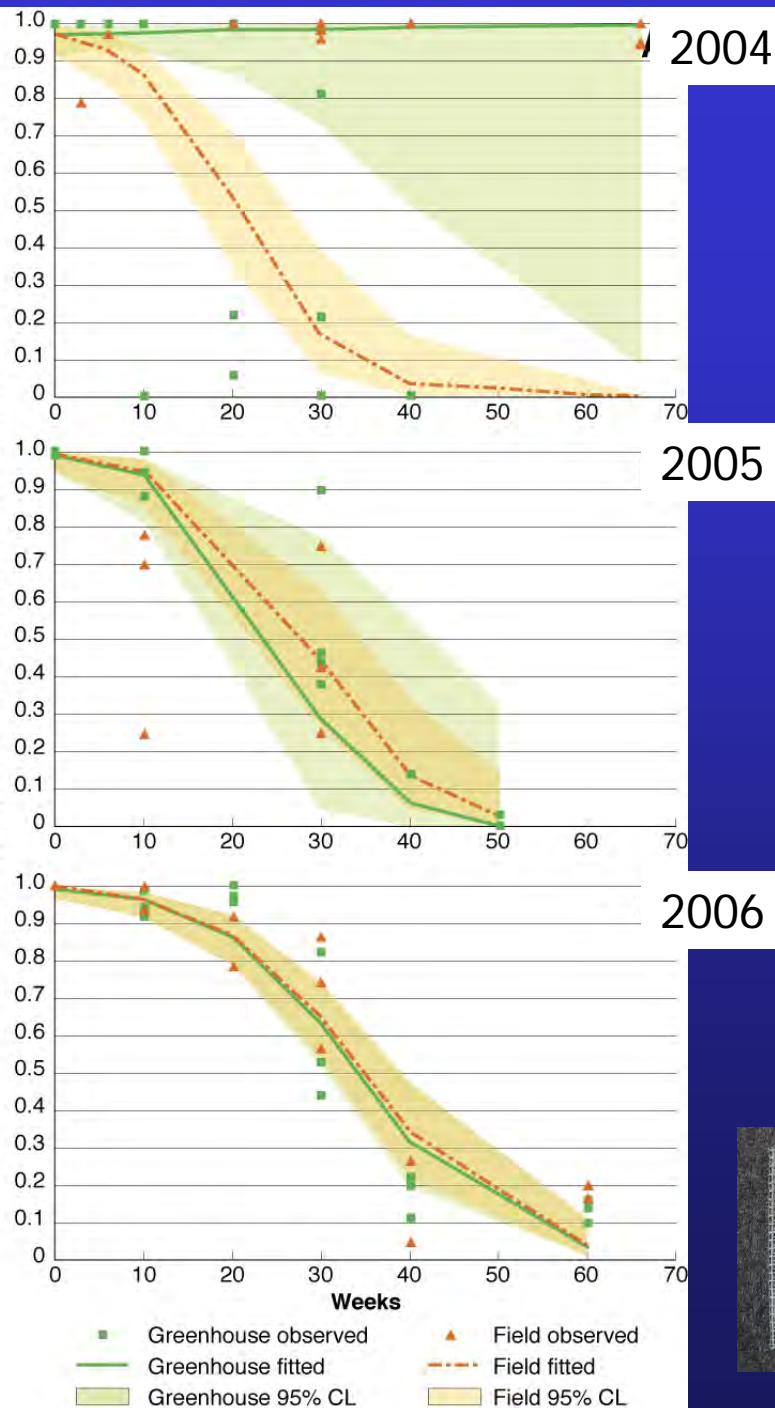
Henry Cowell State Park

Shoe washes: detection vs rainfall
2002



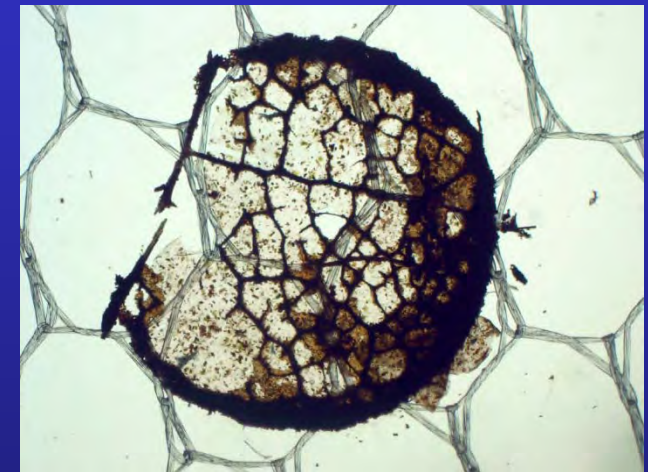
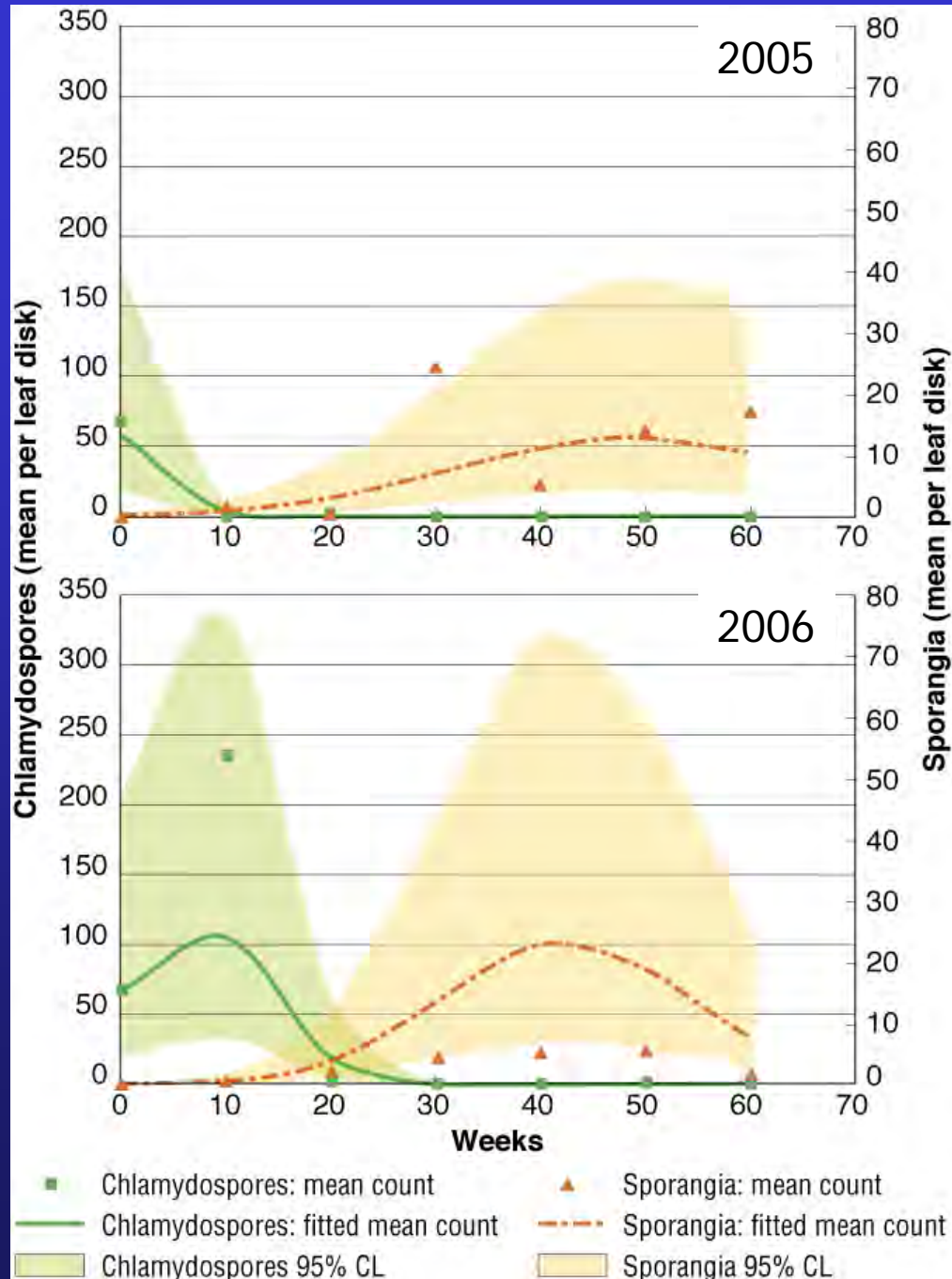
Recovery of *P. ramorum* from buried infested leaf disks in soil-field and greenhouse

Proportion of positive detections of remaining disks



Infected leaf disks were buried below the soil surface and retrieved

Production of chlamydospores and sporangia



Leaf disks removed from field soil
Placed in Petri plates and flooded
with deionized water, incubated
7 days at 20 C.

Root Infection

Experiment 3 (2006-07)

- 20 weeks- no *P. ramorum* in roots
- 30 weeks- no *P. ramorum* in roots
- 40 weeks- *P. ramorum* in roots from Field
- 60 weeks- *P. ramorum* in roots from Greenhouse

Foliar infection

Leaves touching infested soil are infected



2004

Foliar infection only on sprinkler irrigated plants and only in lower shaded leaves



2005

Management in Nursery

Preventing Introduction and Persistence

3. Chemical treatments to prevent establishment and persistence

- Keep in mind resistance management too.

Fungicides for *P. ramorum*

Rhododendron, Camellia, Pieris, and Viburnum

Pre-infection (preventative) fungicide application

- Foliar application
 - mefenoxam (Subdue Maxx, Syngenta)
 - dimethomorph (Stature DM, BASF)
 - pyraclostrobin (Insignia, BASF)
 - fenamidone (Fenstar, Olympic)
 - cyazofamind (Segway; FMC, turf only)
- Preventative control for at least 4 weeks, except for rhododendron, which was at least 2 weeks.
- When lesions developed, the pathogen was successfully recovered from those lesions. Only dimethomorph and cyazofamid reduced recovery success rate.

Post-infection (curative) fungicide application

- No reduction in lesion growth
- High rate of recovery of pathogen with all fungicides. For rhododendron, the pathogen could be recovered reliably for at least 6 weeks after fungicide application from intact and fallen leaves.
- Re-isolations from leaves treated with dimethomorph and cyazofamid were weak in culture

Management in Nursery

Preventing Introduction and Persistence

1. Inspection of plant introductions and nursery scouting
2. Cultural practices to prevent movement and persistence within nursery
3. Chemical treatments to prevent establishment and persistence



Nursery Industry BEST MANAGEMENT PRACTICES for *Phytophthora ramorum* - to prevent the introduction or establishment in California nursery operations Version 1.0



ENDORSEMENTS

CA Association of Nurseries
and Garden Centers
Nursery Growers Association
CA Farm Bureau
San Diego Flower and
Plant Association
Garden Rose Council
CA Oak Mortality Task Force
California Center for
Urban Horticulture, UC Davis
Horticultural Research Institute

PHOTO

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COVER PHOTO

Briggs Nursery in Bonelli, CA,
ERIC LARSON, photographer



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Nursery Guide for Diseases Caused by *Phytophthora* *ramorum* on Ornamentals: Diagnosis and Management

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INTRODUCTION

Phytophthora ramorum, a newly discovered plant pathogen, has caused widespread mortality in native oaks and tanoaks in many coastal areas of central and northern California and in southwestern Oregon. On oaks, the disease is commonly called sudden oak death because trees typically appear to die rapidly (fig. 1). In infested wildlands (forests and woodlands), the pathogen has been detected on several other trees, shrubs, vines, and herbaceous native plants, where it causes less-destructive leaf blights, stem cankers, and tip dieback.


Camellias, rhododendrons, and other popular ornamental plants are susceptible to *P. ramorum* infection, and the pathogen can be moved long distances through shipments of infected nursery stock. By the end of 2004, the pathogen has been detected on nursery stock and some outplantings in 21 U.S. states and British Columbia. Federal and state quarantines are in effect that require nursery inspections, and if the pathogen is found, affected nursery stock must be destroyed as a means of eradication.



Figure 1. Coast live oak mortality, Santa Cruz County, CA, 1999. Photo: S. Tjosvold.



Grower-oriented Publications



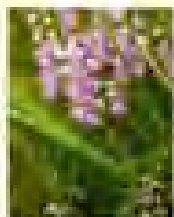
CALIFORNIA OAK MORTALITY TASK FORCE

Sudden Oak Death and the California Oak Mortality Task Force

The California Oak Mortality Task Force (COMTF) focuses on the plant pathogen *Phytophthora ramorum*, which can have devastating effects in the wildlands it inhabits and has had substantial impacts on the nursery industry internationally. In 14 coastal California counties and Curry County, Oregon, *P. ramorum* has caused outbreaks of Sudden Oak Death, killing tens of thousands of native oak and tan oak trees. The pathogen also infects the leaves and twigs of common ornamental nursery plants, such as rhododendrons and camellias, which serve as vectors for pathogen dispersal.

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Current Report: [October 2004](#)

Host of the Month: October 2004



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California Oak Mortality Task Force
www.suddenoakdeath.org

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CANGC: California Association of Nurseries and Garden Centers

