



Monitoring *Phytophthora ramorum* Distribution in Streams within California Watersheds

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Objectives

- Early detection of new *P. ramorum* infestations
- Monitor *P. ramorum* distribution across California
- Test and adapt methods for effective detection and monitoring

Phytophthora ramorum

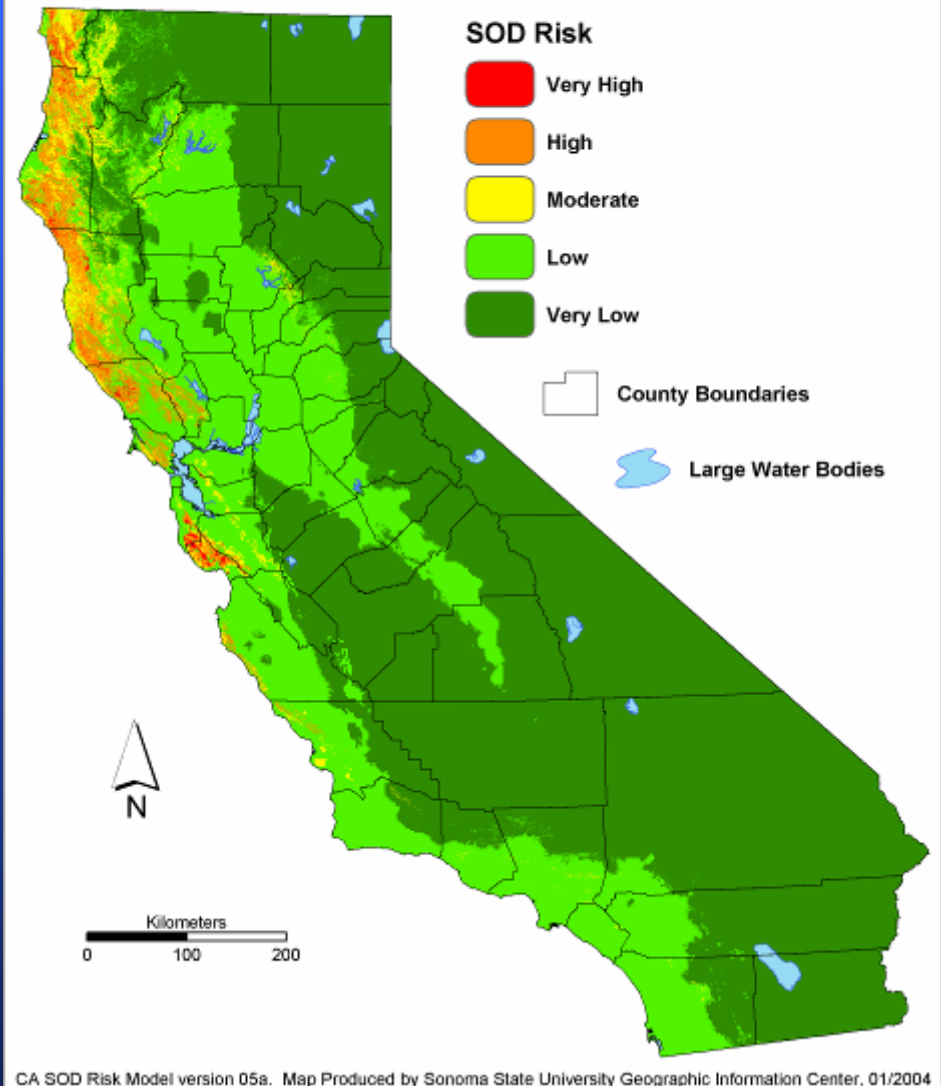
- causal agent of Sudden Oak Death (SOD)
- Caused extensive mortality of *Quercus* sp. and *Lithocarpus densiflorus* (tanoak) over the past decade
- Primary epidemic area (>SF Bay Area) with expanding range
- Infects over 25 California native plants across 12 plant families

Distribution & Risk



current distribution as of 9/20/06

Risk of Establishment and Spread of Sudden Oak Death in California



Source: Meentemeyer et al., 2004

Overview

- 113 sites sampled between 2004 and 2006
 - ✓ throughout central and northern coastal CA and northern Sierra Nevada
- Variety of stream sizes
 - ✓ range from small creeks (~100 acres) to large rivers (>200,000 acres)
- Site selection
 - ✓ areas with limited or no *P. ramorum*
 - ✓ high-risk for invasion
 - ✓ reasonable access
 - ✓ perennial streams

Field Methods

- 10 *Rhododendron* leaves in sterilized fiberglass mesh bags per location
- two replicate locations per site
- Bags attached to streambanks and floated on surface for 7-21 days
- adjusted year-round air/water temperatures & water flow
- Sampled on 4-6 week intervals



Laboratory Methods

- Leaves surface sterilized (95% EtOH), DI water rinse, air-dried
- Disease symptoms described for all leaves
- Symptomatic leaves isolated to PARP with 0.025g/L hymexazol
- Plates incubated (18°C) for 3 weeks
- checked microscopically twice weekly
- Any *Phytophthora*-like organisms further examined



P. ramorum zoospore infection in laboratory

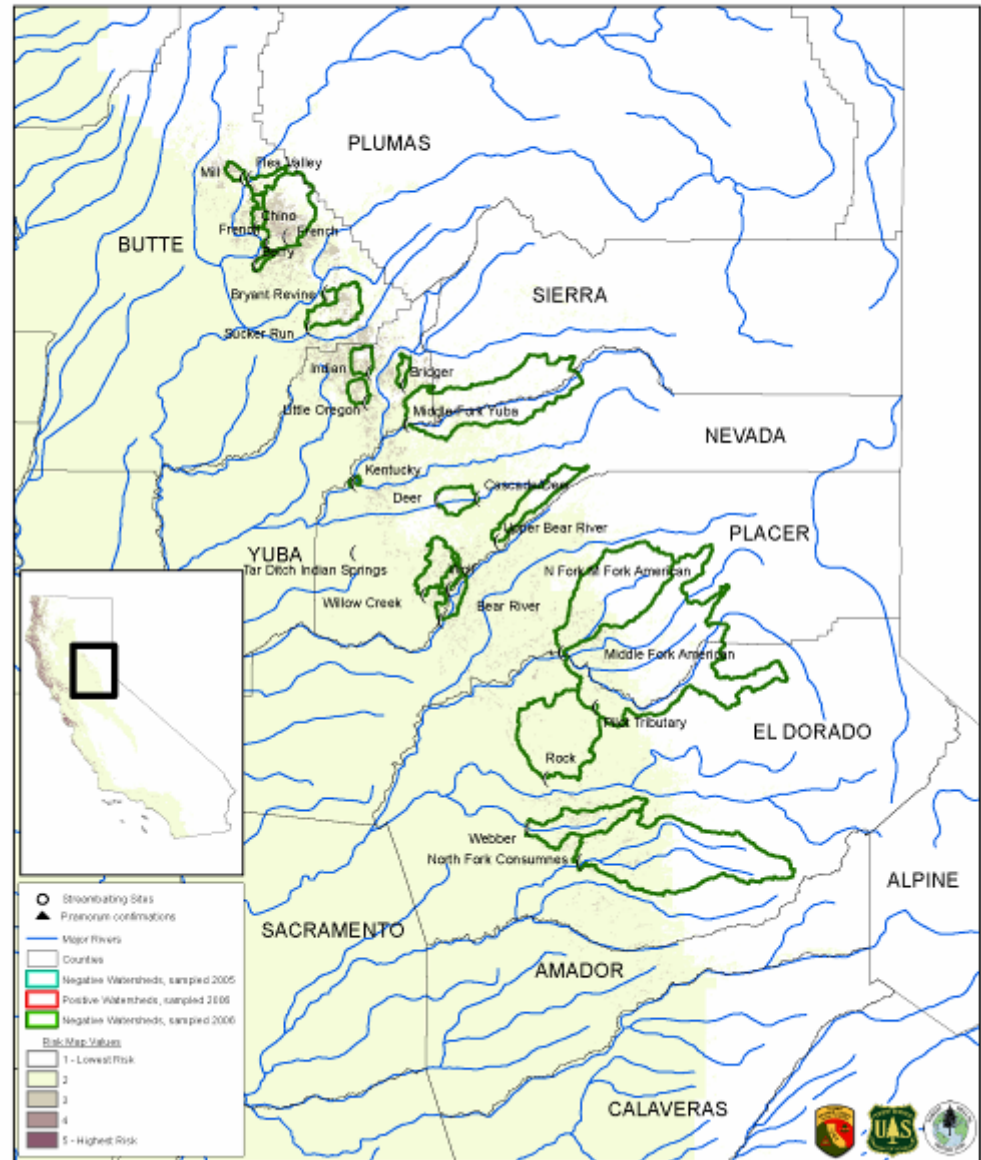


Natural infection by *P. ramorum*

California Stream Monitoring Sites

National SOD Survey Streambaiting Sites *DRAFT*

Butte, El Dorado, Nevada, Placer, Yuba Counties



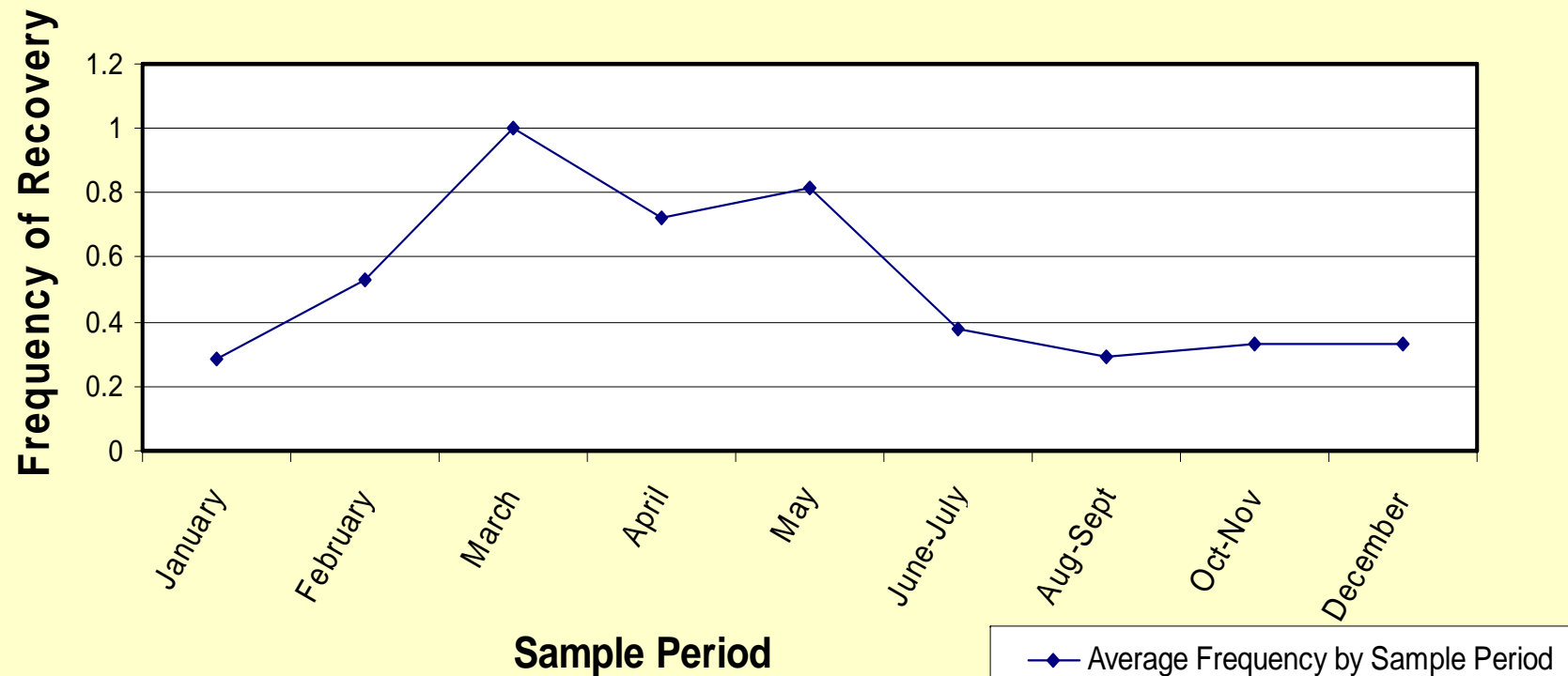
Results

- 27 watersheds infested with *P. ramorum*
 - ✓ detected at all sites with prior knowledge of forest infestation
 - ✓ 14 sites without known forest infestation
 - Humboldt, Contra Costa, Santa Cruz and Monterey counties- confirmed at only 8 of 14
 - ✓ recovered as far as 7km downstream of forest infestations
- Observed infected tanoak trees at high water levels at two sites in 2006
 - ✓ *P. ramorum* transmission back to land?
- Recovered *P. ramorum* at wide range of water temperatures (6°C to 25°C)

Results...

- Year-round sampling reveals seasonality differences in recovery

Frequency of *P. ramorum* recovery in 2004 and 2005



Results...

- extended the range of *P. ramorum* to:
 - ✓ Willow Creek (Monterey) in the south (3km)
 - ✓ Elk Creek (Humboldt) in the north (5km)
- All sites in Sierra Nevada remain negative
- culturing and sequencing identified other *Phytophthora spp.* throughout watersheds
 - ✓ *P. gonapodyides* isolated at 49 sites throughout the range
 - ✓ Still many unknown *Phytophthora spp.* remain
- Effective early detection strategy

Future Directions

- Identify unknown *Phytophthora* species with molecular analyses (e.g. sequencing, SSCP analysis)
- Address research questions related to spread, survival, and quantification of *P. ramorum*
- Expand efforts with more extensive monitoring, particularly in Humboldt County and other recently infested areas

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