

Monitoring *Phytophthora ramorum* Distribution in Streams Within California Watersheds¹

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Abstract

One hundred-thirteen sites were established in perennial watercourses and sampled for 1 to 3 years between 2004 and 2006 to monitor for presence of *Phytophthora ramorum* throughout coastal central and northern California watersheds as well as portions of the Sierra Nevada mountain range (Murphy and others 2006). The majority of the monitored watersheds have limited or no *P. ramorum* at this time, but are near the epidemic range of *P. ramorum* and/or are considered high-risk for invasion by *P. ramorum*. Three currently infested watersheds in Sonoma and Mendocino counties were included as a baseline for successful recovery of *P. ramorum*. *Rhododendron* leaves were placed in fiberglass mesh bags, secured to streambanks, and floated on the water surface for 1 to 3 week intervals to bait for *Phytophthora* species (von Broembsen 2002; E. Hansen, personal communication 2003; P. Maloney and J. Davidson, personal communication 2003). The interval time was adjusted year round with the minimum time during periods of warm stream and air temperatures and longer intervals in cold conditions. Recovered symptomatic leaves were described and isolated onto *Phytophthora*-selective medium augmented with 25 mg/L hymexazol to inhibit growth of *Pythium* species (PARP-H). Experiments have shown minimal inhibition of *P. ramorum* and other *Phytophthora* species growth with this concentration of hymexazol (Fichtner and others 2006; Murphy, unpublished data; E. Hansen, personal communication 2004; S. Jeffers, personal communication 2005). Plates were incubated at 18°C for three weeks and checked microscopically twice weekly for growth of *Phytophthora* species; any *Phytophthora*-like organisms were transferred and further examined for identification.

Twenty-seven watersheds were infested with *P. ramorum*, including all sites with a priori knowledge of forest infestation. *Phytophthora ramorum* was found at 14 sites without prior knowledge of forest infestation in Humboldt, Contra Costa, Monterey, and Santa Cruz counties. Forest infestations have thus far been confirmed at only nine of those sites with surveys underway to identify the source(s) of inoculum for the other five sites. Additionally, *P. ramorum* was recovered as far as 7 km downstream from known forest infestations. At two sites in 2006 we observed *P. ramorum* infected plant lesions at high water levels, indicating the possibility of pathogen transmission back onto land from infested water courses. This monitoring has extended the southern range of *P. ramorum* to Willow Creek in Monterey county and the northern range to Elk Creek in central Humboldt county. All sites in the Sierra Nevada remain negative for *P. ramorum* infestation. With culturing and molecular sequencing

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we have also determined the presence of several other *Phytophthora* species throughout these watersheds, including primarily *P. gonapodyides* which was isolated from 60 sites throughout the range of sampling. Sites were monitored year round in 2004 and 2005 and revealed a distinct seasonality associated with *P. ramorum* recovery (fig. 1).

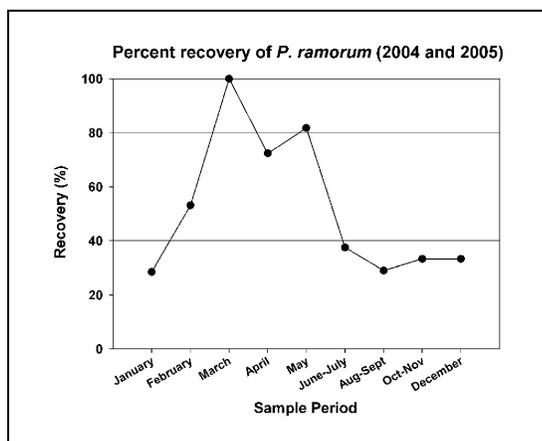


Figure 1—Seasonality of *P. ramorum* recovery from pathogen positive stream sites. Percent recovery for each sample period is averaged from sampling completed in 2004 and 2005.

Stream monitoring provides a useful method of early detection for *P. ramorum* infestation in watersheds. A portion of this work is part of the national *P. ramorum* stream monitoring program supported by the United States Department of Agriculture (USDA)-Forest Service. This project involves many collaborators whose funding, assistance, permission, and guidance make this work possible including: University of California (UC) Davis, UC Cooperative Extension for Humboldt and Del Norte Counties, Cal Poly State University, California Department of Forestry and Fire Protection, UC Angelo Coast Reserve, Landels-Hill Big Creek Reserve, Fairfield Osborn Preserve, UC Berkeley Blodgett Forest Research Station, Hoopa Indian Tribe, Yurok Indian Tribe, East Bay Regional Parks, California State Parks, Sonoma State University, and USDA-Forest Service Forest Health Protection.

In 2007, we will expand monitoring efforts in Mendocino and Humboldt counties to more extensively monitor newly infested and high-risk watersheds. We will additionally survey to locate sources of inoculum and infestation in newly identified positive watersheds. Future studies will include identification of unknown and other *Phytophthora* species occurring in stream courses with molecular analyses. Furthermore, we will work to address research questions related to spread, survival, and quantification of *P. ramorum* in stream courses.

Key words: *Phytophthora ramorum*, water sampling, stream baiting, watershed, California.

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