

Epidemiology of *Phytophthora ramorum* in Oregon¹

E.M. Hansen², A . Kanaskie⁴, E.M. Goheen³, N. Osterbauer⁴, and W. Sutton²

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Introduction

We are studying how *P. ramorum* survives and spreads in Oregon tanoak forests. The Oregon outbreak is similar to the epidemic in redwood-tanoak forests of California, with several important differences, however. The disease is confined to scattered stands within a 12 m² area, and it is subject to an ongoing eradication effort. While eradication has not yet eliminated the disease, inoculum levels are low. As a consequence, myrtlewood is seldom infected and is not important in the epidemic.

Results

Based on 1996, 1998, 2000, and 2001 color aerial photographs of the current outbreak area, the disease is of recent origin in Oregon. The first dead tanoak is visible on a 1998 photograph at one site. At the four other sites examined, the first dead trees are visible on the 2000 images. Dead trees increased rapidly through 2001, when *P. ramorum* was first identified and eradication began. The number of dead trees at the 1998 site increased from one to seven to 110 on the three sets of photographs.

We have been monitoring five eradication sites from 2001. Rainwater and streams were sampled for *P. ramorum*, and persistence of the pathogen in soil and on plants growing around the stumps of infected tanoak trees was periodically measured. Susceptible Douglas-fir and redwood seedlings were planted around stumps. In addition, other sprouting host plants were examined for infection. *P. ramorum* was recovered only once from a rain trap, and is no longer sampled. The pathogen is still recovered from

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² Department of Botany and Plant Pathology, Oregon State University, Corvallis OR USA 97331, hansene@SCIENCE.oregonstate.edu

³ USDA Forest Service, SW Oregon Forest Insect and Disease Center, Central Point OR 97502

⁴ Oregon Department of Agriculture, Salem OR, 97310

streams 36 months after site treatment, although no new plant infections have been associated with infested streams. Eighty-eight percent of the 43 stumps sampled tested positive for the occurrence of *P. ramorum* in the associated sprouts. Infection appeared to result both from cankers already present on the stumps, and from inoculum splashed from below. Sprouts were destroyed with herbicides, and although tanoak, wild rhododendron, and evergreen huckleberry have resprouted on many plots, there were no new sprout infections detected in 2004. Douglas-fir and redwood seedlings were not infected. *P. ramorum* was recovered from soil around 18 percent of the stumps in 2004. Survival of *P. ramorum* on eradication sites was tested with inoculated tanoak and rhododendron leaves. Recovery from leaves on the soil surface dropped to near zero in 3 months, but stayed near 80 percent from buried leaves (McLaughlin, Poster in this Proceedings).

Tanoak trees with bole cankers but with green foliage, and adjacent green trees without bole cankers were felled. *P. ramorum* was isolated from leaf and twig lesions from the upper crowns of 11 of 15 tanoak trees with bole cankers, and from three of the 12 nearby canker-free trees. Infection of rhododendron and huckleberry in the understory was found only in the immediate vicinity of cankered trees. The results suggest downward spread of *P. ramorum* in a tree, from stem flow and rain splash.

New infections are mapped annually and confirmed by isolation and PCR. The distance of 137 newly detected trees (2002, 2003, and 2004) from the nearest tree detected in a previous year was calculated and plotted. The result resembles a classic aerial dispersal gradient of an infectious disease. Most new infections occur close to previously infected trees, but there is a long tail to the distribution, suggesting occasional dispersal in storm winds. About 50 percent of new infections occur within 100m of older infections. There is no “background” of infection, and there is no evidence to suggest disease spread along roads or in streams. Infected tanoaks are clustered on the landscape and are not uniformly distributed. This reflects the local intensification of infections, with occasional “spotting” via long distance dispersal. These jumps are initially detected from the air as single red-crowned trees. Follow up ground checking may reveal bole cankers on a few neighboring green trees. Eradication is imposed at this stage, but newly dead trees are often detected on the perimeter of the treatment area in the next year’s survey.

Discussion

These results are fully consistent with a recently introduced exotic pathogen, spreading by passive aerial dispersal across the landscape, with local intensification by drip and splash. Sporangia are the likely dispersal propagules. New microsatellite markers

developed by Prospero (Poster, this Proceedings) may provide an independent test of these epidemiological hypotheses for *P. ramorum*.