

A Spatial Analysis of *Phytophthora ramorum* Symptom Spread Using Second-Order Point Pattern and GIS-Based Analyses¹

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Abstract

Phytophthora ramorum is a major source of tanoak (*Lithocarpus densiflorus*) mortality in the tanoak/redwood (*Sequoia sempervirens*) forests of central California. This study presents a spatial analysis of the spread of the disease using second-order point pattern and GIS analyses. Our data set includes four plots in tanoak/redwood (*Sequoia sempervirens*) forests in Marin County, California. Each plot contains roughly 400 individual stems. We transformed our point pattern maps into continuous density surfaces using a gaussian kernel function for the 2001 and 2003 disease symptom surveys. Subtracting one year from the other with a cut and fill function we in turn developed a triangulated irregular network (TIN). The TIN provides a means to estimate the spread of symptoms, directionality of spread and the average increase of symptomatic stem density. Our analysis indicates an average median spread of 2.1 meters and an average density increase that ranged from 32 to 100 symptomatic stems per hectare between 2001 and 2003. We detected no signs of anisotropy. Our localization of the scale of spread using Ripley's L(t) analysis supports the GIS analysis results. Together these results reflect a spread of disease from existing foci without the development of new foci within the stands.

Key words: sudden oak death, *Phytophthora ramorum*, spatial spread analysis

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