



Potential climatic suitability for establishment of *Plytophthora ramorum* within the contiguous United States

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Abstract

Phytophthora ramorum has caused extensive mortality to tanoak and several oak species in coastal California. This pathogen has infected at least 72 plant species under natural conditions and 32 additional species in the laboratory. Many infected hosts have been distributed across the United States by the horticultural industry. We developed a simulation model using CLIMEX software to evaluate the suitability of the climate in the United States for establishment of *P. ramorum*. CLIMEX was driven by monthly climate normal data for 1971–2000 collected from >5300 weather stations in the contiguous United States. CLIMEX growth-requirement and stress-response parameters were derived from literature data. Values for the ecoclimatic index (EI), a measure of overall climatic suitability based on temperature and soil moisture, were between 0 and 53. Much of the Intermountain West and the Great Plains was climatically unsuitable for establishment of *P. ramorum* (EI = 0). Many states bordering the Great Lakes were marginal (0 < EI < 11). Areas considered climatically highly favorable (EI > 25) for establishment of *P. ramorum* were common in the Gulf States, and areas considered favorable (10 < EI < 26) extended into southern Illinois, southern Indiana, and northwards into southern Maine. Predictions derived from CLIMEX matched known occurrences of *P. ramorum* in California and Oregon. Finds of the pathogen were 3.4-times more likely in areas classified as favorable or very favorable than in areas classified as marginal or unsuitable. Model results were only modestly sensitive to changes in values assigned to temperature parameters for growth but were more sensitive to changes in values assigned to moisture parameters for growth. Additional research is needed to determine the effects of low moisture on population growth of the pathogen. Nevertheless, our model distinguishes some areas within the contiguous United States that do not have a suitable climate for the pathogen. Such information could be used to refine survey and detection programs.

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1. Introduction

Significant mortality of tanoak (*Lithocarpus (L. densiflorus)*), coast live oak (*Quercus agrifolia*), California black oak (*Q. kelloggii*), and Shreve's oak (*Q. porvuhrii* var. *shrevei*) was first observed in 1994 in the western United States and attributed to the disease Sudden oak death. The causal agent of this disease was later confirmed as *Phytophthora ramorum* (S. Werres, A.W.A.M. de Cock and W.A. Man in't Veld) (Garbelotto et al., 2001; Hansen et al., 2002; Rizzo et al., 2002a; Garbelotto et al., 2003). The pathogen also causes ramorum bleeding canker,

ramorum leaf blight, and ramorum shoot dieback in more than 68 additional plant species in 28 families in the wild and another 32 species under conditions (Davidson et al., 2003; DEFRA, 2004b; Tooley et al., 2004). Foliar hosts, especially tanoak, California bay laurel (*Umbellularia cal-*

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