Effects of Diversity, Topography, and Interannual Climate Variability on Pathogen Spillover[1]

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Abstract

Our knowledge of sudden oak death (SOD) disease dynamics indicate that without bay laurel (*Umbellularia californica*) there is seldom oak (*Quercus*) infection. This requirement of an alternate host species for disease transmission to oak species is an example of pathogen spillover. We developed a path analysis to test specific hypothesized relationships between physical and ecological factors affecting pathogen spillover. Path analysis enables simultaneous examination of direct and indirect effects from multiple factors, which can enhance our understanding of the multiple influences on pathogen spillover in SOD. We rooted our path model with the topographic wetness index, indicating potential soil wetness and moisture persistence, and examined the direct and indirect effects of species diversity, temperature, precipitation, and bay laurel density on potential inoculum load and infection of oak species.

We applied 10 years of data from a long-term SOD-monitoring plot network in southeastern Sonoma County, CA. Each of the 200 15-m by 15-m plots was equipped with a temperature logger and plots were visited once per year from 2004 to 2012, and in 2014 to assess *Phytophthora ramorum*/SOD host species for disease symptoms and download temperature data. We inspected oak species for canker symptoms and indexed potential inoculum load by counting symptomatic leaves on each bay laurel stem for 60 seconds. We recorded the abundance of all tree species rooted in each plot during visits in 2005 and 2014 to quantify community diversity. Rainfall was measured at 15 rain gauges installed throughout the study area during this period.

We conducted a piecewise assessment of the path model, enabling us to account for the repeated measures structure of these data. Results from our path model of disease observations aggregated to the plot level revealed that diversity mediates the potential for pathogen spillover through a relatively strong direct negative effect on oak infection. Potential inoculum load on bay laurel had a direct positive effect on oak infection, with its overall influence moderated by temperature, topography, and diversity. Temperature and rainfall had relatively weaker influences on pathogen spillover compared to diversity and inoculum load. The net negative effect of diversity on oak infection is consistent with the dilution effect found in other studies of SOD. Topographic wetness had significant direct influence on diversity and inoculum load, where higher values of the wetness index tended to have lower values for diversity, but higher values for inoculum load. This is consistent with areas where moisture is likely to accumulate and persist providing a more favorable environment for *P. ramorum* sporulation.

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