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Spread of sudden oak death: Application of stochastic epidemic modeling to realistic landscapes

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Background/Question/Methods
As the number of emerging infectious diseases (EIDs) continues to rise, prediction of disease outbreaks is critical for effective management and prevention of epidemics, especially in complex spatially heterogeneous landscapes. Epidemiological models of Susceptible-Infectious (SI) transitions increasingly incorporate effects of spatial heterogeneity, but are rarely applied to realistic landscapes of host availability, infection pressure, and abiotic conditions, limiting our ability to map hotspots for disease outbreaks and assess the geography of disease dynamics. In this paper, we describe and validate a stochastic epidemic model, applied to temporally and spatially heterogeneous landscape data mapped in a GIS, to predict the spread of the invasive forest pathogen *Phytophthora ramorum*, causal agent of the EID sudden oak death. Previously collected field and lab data were used to parameterize key system variables that affect establishment and spread of *P. ramorum*, including weather conditions, host infectiousness and availability, and a statistically-estimated dispersal kernel.

Results/Conclusions
Implemented on a weekly time step (1990-2030), the model considers three distinct epidemiological processes to forecast disease spread across the state of California at a spatial resolution of 250 m: production of inoculum by infected cells, dispersal of inoculum, and probability of infection. We established 784 field plots across the pathogen's potential geographic range to examine the correspondence between predicted spread of disease and observed spatial distribution of disease incidence in 2006. Model predictions have a high degree of correspondence with field observations of disease distribution and identify numerous forest ecosystems at high risk of infection. The nature of prediction errors are examined by ecoregion, plant community, and climate, and we discuss how application of

epidemiological models to realistic landscapes in a GIS fosters understanding of spatially-explicit processes and designing management strategies to control spread.