Sudden Oak Death Disease Progression in Oaks and Tanoaks

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In March 2000, we established twenty disease progression plots in Marin County to monitor the progress of sudden oak death symptoms. Plots were located to encompass a variety of habitat types and species combinations, 10 in China Camp State Park and 10 in Marin Municipal Water District. We monitored every coast live oak (731), black oak (52), and tanoak (181) with a stem diameter greater than 2.5 cm, four times a year. Trees were evaluated by symptom and not sampled for *Phytophthora ramorum* to avoid affecting disease progression. Bleeding coast live oaks were found to follow a consistent and predictable sequence: bleeding, beetle colonization, and emergence of *Hypoxylon thouarsianum* reproductive structures, prior to death. For all species, the numbers of bleeding and dead trees increased by 2004, with the greatest increases seen in tanoaks. The percentage of living coast live oaks that were bleeding remained relatively constant through 2004, at around 25%. The proportion of bleeding tanoaks increased from 39% to 72%. Approximately 50% of bleeding coast live oaks were under active attack by ambrosia and bark beetles (*Coleoptera*: *Scolytidae*) or showed past beetle activity during the March sampling period, 2000 to 2004. Beetles had colonized every bleeding coast live oak that died during this study while it was still alive.

We used a Weibull regression model to predict survival functions for same-symptom cohorts (status in 2000) of coast live oaks and tanoaks. The model provided estimates for survival of trees in the following disease categories; asymptomatic, bleeding only, and bleeding with beetle colonization. The median survival time for coast live oaks declined considerably as a function of disease state: asymptomatic > bleeding only > bleeding with beetles. The presence of *H. thouarsianum* did not change survival. The median survival times for tanoaks also declined in this order. The Weibull model was used to estimate the median asymptomatic time for these two species, as a function of stem diameter (dbh). For both tanoaks and coast live oaks, predicted asymptomatic times declined as diameter increased, with the greater decline in tanoaks. Structural failure on the main stem (bole) occurred in bleeding coast live oaks with a much greater frequency than in asymptomatic trees of this species, or in either bleeding black oaks or tanoaks.