

Long-Term Monitoring of Sudden Oak Death in Marin County and the East Bay Hills¹

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Abstract

Prior to 2000 the etiology, effects on host trees, and possible consequences for northern California's forests of the syndrome known as sudden oak death were unknown. We designed a plot-based study to address these issues and to set a baseline for future evaluations.

In March-April 2000 we established a total of 20 plots in two forested areas in Marin County: China Camp State Park [CCSP] (10) and Marin Municipal Water District [MMWD] (10). The host species monitored were coast live oak [CLO] (*Quercus agrifolia*) and California black oak [CBO] (*Q. kelloggii*) in both sites and tanoak [TO] (*Notholithocarpus densiflorus*) in MMWD. We employed symptom-based monitoring on every stem >2-cm DBH (1.37-m), twice per year through 2007, then once per year through 2015. Symptom categories were bleeding; bleeding plus ambrosia and bark beetle attacks; bleeding plus beetles plus *Annulohyphoxylon thouarsianum* sporocarps; and death. Trees that died without these symptoms were classified separately. Between 2000 and 2015, asymptomatic CLOs (n = 683) decreased from 68.8% to 42.9% and mortality increased from 6.7% to 40.5%. For CBO (n = 52), asymptomatic trees declined from 82.7% to 47% and mortality increased from 1.9% to 40.8%. For TO (n = 132), the asymptomatic trees decreased from 62.9% to 21.9% and mortality increased from 6.1% to 62.3%. The percentages of symptomatic trees declined from 22.4% to 8.7% for CLO and 31% to 15.9% for TO.

Of the CLOs that were asymptomatic in 2000 (n = 454), 22% were dead with SOD symptoms by 2015 and 10% were symptomatic. However, another 14% were in remission, which we define as cessation of bleeding for at least three years prior to 2015 in a previously symptomatic tree (in the absence of beetle attacks). Although the long-term durability of remission is not known, our previous estimates of CLO infection levels did not recognize the remission category.

Phytophthora ramorum was not detected in Alameda County until 2001, 7 years after the first mortality was observed in Marin County. This presented an opportunity to apply our knowledge of SOD to provide the East Bay Regional Park District (EBRPD) with a scientific basis for developing management plans. We initiated landscape-scale monitoring of CLO in five EBRPD parks in 2008 to determine the extent of the epidemic in the oak-bay vegetation type and to estimate infection and mortality rates. A total of 535 10-m radius fixed plots were randomly assigned in oak-bay stands between 2008 and 2011. In three large parks, Redwood, Wildcat Canyon, and Anthony Chabot, infection levels in 2015 were between 14.3% and 19.0%. By examining only CLOs that were asymptomatic in 2011 in these three parks, we calculated infection rates between 3.6% and 4.8% per year. Based on the estimated numbers of mature (>20-cm DBH) CLOs in these parks, we can predict approximately 5,000 new infections per year per park. It is of interest that these new infections occurred during a historical drought that had been expected to reduce infection rates. We have been sampling phloem from trees that exhibit remission or have remained

¹ A version of this paper was presented at the Sixth Sudden Oak Death Science Symposium, June 20-23, 2016, San Francisco, California.

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asymptomatic in sites with high infection levels to estimate the levels of resistance across the parks using chemical biomarkers (in collaboration with the Bonello lab at Ohio State University).