Forecasting the Future of Coast Live Oak Forests in the Face of Sudden Oak Death[1]

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Abstract

Little is known about the potential short- and long-term impacts of sudden oak death (SOD) on forest structure and composition. This study began in 2002 to evaluate the effects of SOD on coast live oak (*Quercus agrifolia*) - California bay laurel (*Umbellularia californica*) forests over a gradient of *Phytophthora ramorum* infection. In order to evaluate stand level impacts of the disease, we present mortality data from three time periods: recent past (five to 10 years before 2002), present (2002-2004), and future (next five years). Because large numbers of recently downed stems (mainly *Q. agrifolia*) were found in 2002, in areas of high known infection levels of *Phythophthora ramorum*, and because most SOD monitoring efforts began in 2001 or later, stand reconstruction methods were employed to accurately capture the impact of the disease on forest stands.

Our eight study sites (1 hectare in size) are located throughout the San Francisco Bay Area. These were chosen based on dominance by *Q. agrifolia* and *U. californica*, and to span a wide variability of *P. ramorum* infection, in terms of visually manifested signs of the disease. Five .08–hectare, fixed-radius plots were placed using a stratified random design within each of the eight study sites, for a total of 40 plots. Results are based on measurement of diameter at breast height (dbh), as well as mortality and disease characteristics of all stems (standing and downed) within these 40 plots. Stems are defined as forking below dbh, and are 10 cm dbh or greater.

To estimate current and past stand parameters, we used tree mortality data collected in the spring of 2002, 2003, and 2004, and stand reconstruction methods to establish (presumed) pre-SOD reference stand structure. Stand reconstruction involved inclusion and measurement of all recently downed stems. Based on a decay index, recently downed stems were defined as stems with fine twigs and leaves still attached or with solid, intact bark. Tissue samples taken from *U. californica* foliage confirmed the presence of *P. ramorum* at six sites at the high and medium ends of the gradient. Based on the decay index and similar studies completed in hardwood forests, we estimate that these stems had senesced within the last five to 10 years. These estimates include background mortality as well as *P. ramorum* - influenced mortality.

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To forecast mortality in the near future, we assumed that all currently bleeding *Q. agrifolia* stems will senesce. Based on our observations and the SOD literature to date, we estimate that these stems will senesce in the next five years. These estimates assume that seeps are due *to P. ramorum*, that current rates of infection will continue, and do not account for potential host resistance.

A total of 1029 *Q. agrifolia* stems were sampled, out of 2306 stems of all species in all plots. Mortality losses are reported in terms of stem basal area (m^2/ha). Results indicate that between 2002 and 2004, from 2 percent (at a low infection site) to 27 percent (at a high infection site) of *Q. agrifolia* basal area (m^2/ha) senesced. From the recent past through 2004, stand reconstruction results indicate that sites have lost from 4 percent (at a low infection site) to 55 percent (at a high infection site) of the *Q. agrifolia* basal area (m^2/ha). Future forecasting results indicate that from the recent past to the future, from 15 percent (at a low infection site) to 69 percent (at a high infection site) loss of *Q.agrifolia* basal area (m^2/ha) will occur. In terms of impacts to the total stand (looking at all species), because of the senescence of *Q. agrifolia* (the dominant or co-dominant tree), up to 42 percent (in a high infection site) of the total stand basal area (m^2/ha) is predicted to be lost within the next five years. The importance of other non-terminal host tree species is expected to increase, in particular *U. californica*, which is the co-dominant in these stands. These estimates of *Q. agrifolia* mortality are greater than previously shown in the literature.

Further analysis will investigate the impacts of SOD on understory light levels, understory shrub and herbaceous layer plant dynamics, and woody seedling and sapling recruitment, over the same gradient of *P. ramorum* infection.