Restoration of Mount Tamalpais Forests Destroyed by the Sudden Oak Death Pathogen[1]

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Abstract

On Mt. Tamalpais, after nearly 20 years of accumulated disease impacts, some tanoak- (*Notholithocarpus densiflorus*) dominated forests where *Phytophthora ramorum* first emerged have converted to brushy fields of tanoak resprouts. *Phytophthora ramorum* has invaded throughout the greater San Francisco Bay Area, and damaged the culturally, ecologically, and economically important forests of Mount Tamalpais, including many stands managed by the Marin Municipal Water District (MMWD) for water yield and recreation. Sustained inoculum loads have resulted in extensive tanoak mortality, in some places almost 100% of initial overstory tanoak trees have been killed by the disease. Tanoak resprouting has formed undesirable forest structure where occasional redwood (*Sequoia sempervirens*) overstory trees co-occur with dense, tanoak shrub understories. These conditions are significant management concerns from the perspectives of fuel loads, maintenance of biodiversity, aesthetics and provisioning of water resources. We instituted a series of replicated management experiments on MMWD lands to identify the most economically and ecologically efficacious actions to restore overstory trees and ecological functions.

We established 30, 1 ac treatment plots across three MMWD sites and randomly assigned treatments in blocks of five plots. In 25 plots, all understory tanoak and shrubs were masticated using a combination of an excavator with a masticating head, a skid-steer with a forestry attachment (masticator head), and hand crews. Treatments removed all hardwoods while retaining conifer (redwood, *Sequoia sempervirens*; Douglas-fir, *Pseudotsuga menziesii*) regeneration. Additional treatments will include manipulation mulch generated by mastication and replanting with *P. ramorum*-resistant species. Each plot was instrumented to measure water outflow, soil respiration, as well as estimate annual net primary productivity and nitrogen use efficiency. Mastication treatments greatly reduced fuel loads, understory density, and prevalence of sporulation supporting species. Using a set of models parameterized with field data, we found that 90% of intact tanoak overstory trees are expected to be retained by the treatment, in part because these individual trees will be isolated from inoculum sources. Soil moisture rapidly increased to field capacity during the onset of winter rains and significant outflow to deep soil layers was observed. Long-term efficacy of these treatments for the goal of restoring carbon sequestration and sustaining water yield are dependent on the success of efforts to reestablish other overstory trees which are not susceptible to *P. ramorum*. These are the first landscape scale restoration treatments implemented in SOD damaged areas, restoration in other habitats is planned to learn more about how to restore ecological benefits in the thousands of acres significantly degraded by SOD in the region.

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