

Managing Redwood Ecosystems Using Sudden Oak Death as a Silvicultural Tool¹

Frederick D. Euphrat²

Abstract

In response to the wave of sudden oak death (SOD), caused by *Phytophthora ramorum*, sweeping the redwood forest ecosystems of California's North Coast, the role of foresters and other ecosystem managers is being tested. On Bear Flat Tree Farm, near Healdsburg, California, Forest, Soil & Water, Inc. (FSW) has conducted a multi-year, multi-treatment approach to take advantage of SOD. Because the seral stage of tanoak is a component of hardwood dominance intermediary between brush and conifers, FSW has used the oncoming wave of SOD to accelerate the ecosystem towards redwood (*Sequoia sempervirens*).

The combination of pathogen and cultural treatments of harvest, planting, pruning and thinning has quickly created a redwood-dominated, vigorously growing stand. The key to this rapid change was planting redwoods near tanoaks prior to mortality and timely thinning. These actions have nearly doubled diameter growth of redwood saplings in a statistically significant test. In addition, the timely management of large woody debris from dead tanoaks creates greater stocking in the forest and addresses damaged crop trees.

Key words: forest, redwood, release, SOD, tanoak, thinning

Introduction

In response to the wave of sudden oak death (SOD), caused by *Phytophthora ramorum*, sweeping the redwood forest ecosystems of California's North Coast, the role of foresters and other ecosystem managers is being tested. The disease strikes tanoak (*Notholithocarpus densiflora*) with unchecked vigor, rapidly altering the species mix, density and lower canopy insolation. Most tanoak are infected to the point of mortality; bay laurel (*Umbellularia californica*) are also infected, but not killed, acting as active host trees for the pathogen. Through the bay laurel, the fungus maintains purchase in the ecosystem (Cobb and others 2013).

Treatment of SOD at the one tree level (for example, potassium phosphite) has been used (Garbelotto and others 2007), but is neither practicable nor desirable at the landscape level. Suggestions for management range from no response to multi-square-kilometer exclusion zones (Cobb and others 2013). Ironically, foresters have been trying to limit tanoak for years; managing the consequences of SOD is a unique opportunity at the ecosystem level.

On Bear Flat Tree Farm, near Healdsburg, California, Forest, Soil & Water, Inc. (FSW) has conducted a multi-year, multi-treatment approach to take advantage of SOD. Because the seral stage of tanoak is a component of hardwood dominance intermediary between brush and conifers, FSW has used the oncoming wave of SOD to accelerate the ecosystem towards redwood. The location of this research is on a Non-Industrial Timber Management Plan (NTMP 1-06NTMP-03 SON) as approved by the California Department of Forestry.

The combination of pathogen and cultural treatments of harvest, planting, pruning and thinning has quickly created a redwood-dominated, vigorously growing stand.

¹ An abbreviated version of this paper was presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, November 3-6, 2014, Visalia, California.

² Adjunct Professor, Santa Rosa Jr. College, Santa Rosa, CA 95401.

The key to this rapid change was planting redwoods near tanoaks prior to mortality. Following mortality, the tanoak sites were quickly replaced by young redwoods (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*) and sub-canopy species, such as whiteleaf manzanita (*Arctostaphylos manzanita*), western raspberry (*Rubus leucodermis*), poison oak (*Toxicodendron diversilobum*), coyote brush (*Baccharis pilularis*) and resprouting tanoaks. This growth was encouraged by increased moisture availability, direct sunlight and canopy space, and reinforced by precommercial silvicultural practices.

The tanoak loss, which is spotty and continuing, has quickly been replaced by the young redwoods. This growth was encouraged by increased moisture availability, direct sunlight and canopy space, and reinforced by cultural practices.

Addressing SOD as an active component of forest management is an opportunity to accelerate ecological succession to a redwood-dominated ecosystem. This research presents quantitative outcomes of the Bear Flat Tree Farm case study.

Study location

This research occurred at Bear Flat Tree Farm, a private forest landholding 8 km (5 miles) due east of Healdsburg, California. The site is a redwood-Douglas-fir ecosystem managed for timber production. Redwood is promoted in this forest, because of its unique qualities both as an ecosystem component and market value. The study site has been logged four times, in approximately 1900 and 1930, then again in 1960 and 2007. The most recent harvest was a single-tree selection, removing about 1/3 of the basal area to a residual of 22.96 to 34.44 m² per hectare (100 to 150 ft² per acre), and stocking of about 210 m³/ha (15,000 board ft/acre).

The location of the study area, indicated as the NTMP, is shown on fig. 1.

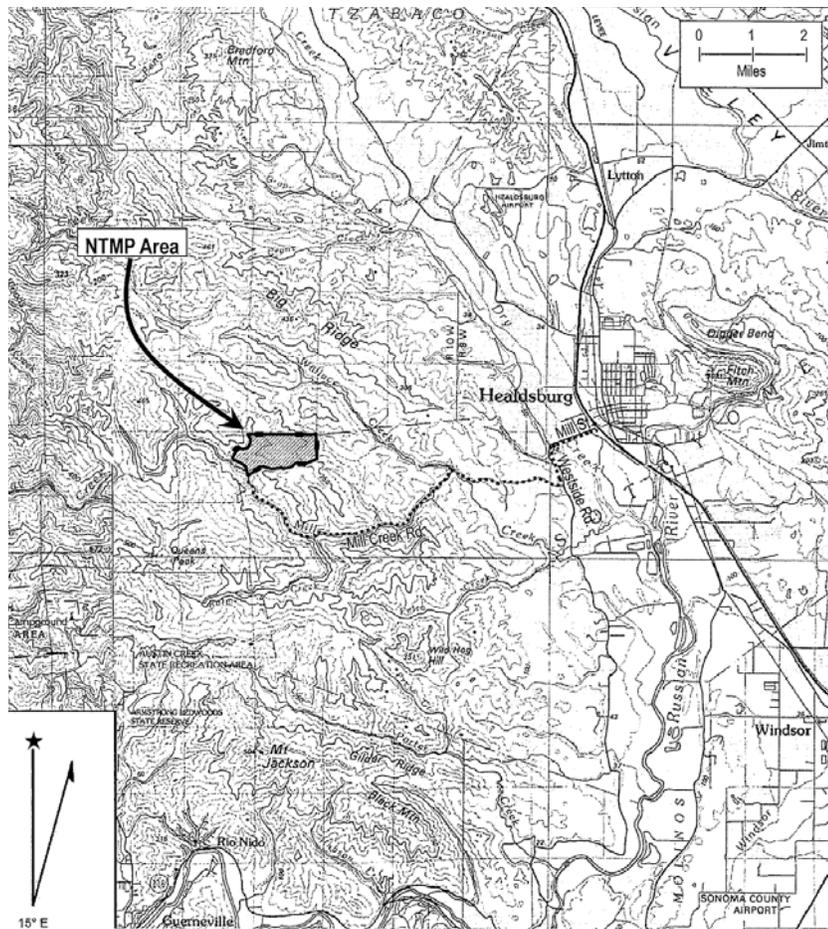


Figure 1—Location of study area.

Rainfall averages 114.3 cm (45 inches) per year (Rantz 1969). Climate is temperate, with snow only rarely. Ocean fog and radiation fog are both common on the site. The moderate temperatures are due to the proximity of the ocean, about 24.1 km (15 miles) to the west, and the topographic conditions of the Russian River watershed, of which this site is a part (Euphrat and others 2006).

Elevation of the sample plots was 274.3 to 304.8 m (900 to 1000 ft) above sea level. The soils are Hugo gravelly loam (HnG) developed on a greywacke parent material (Miller 1972). The aspect of the sites was northerly, approaching a ridgetop. The study area was selected for its distinct uniformity of ecosystem, harvest history, treatment differences, and homogeneity of soils and topographic position.

Treatment

The saplings studied were planted in 2008 and 2009, so are presently 5 and 6 years in the ground. Seedlings were a combination of bare root and plug stock, 1 and 2 years old at planting. Those seedlings are in both control and treated areas.

Following planting, a precommercial thinning was implemented in 2012 to release the redwoods and to reduce tanoak slash. This practice is tree specific, and reduces competition around redwood saplings. With SOD in the stand and redwoods planted near the at-risk trees, a great deal of clearing is already occurring. Stand management

tunes those clearings and releases redwood from the physical effects of the falling tanoak.

The control area was not thinned, though it had mortality from SOD.

Hypothesis

Stand improvement following SOD increases the growth of pre-planted redwood seedlings significantly. This is being tested for management of the redwood stand as a commercial forest.

Study design

Two areas of regenerating redwood-Douglas-fir forest received similar historical treatments of timber harvest, thinning and tree planting. Both areas were similarly infested with SOD, affecting tanoak and bay laurel species. Tanoak trees died and fell on both sites, creating breaks in the canopy. This study focused on the redwoods near those dead tanoak trees (snags) and stumps.

Thirty-one 3 m (10 ft) diameter plots were centered on SOD-killed tanoak snags and stumps. Within those circles, 0.00024 ha (1/139 of an acre), all redwood saplings were measured for diameter (with a ruler) at 15.24 cm (6 inches) from the ground, height (taped or estimated), and distance from the stump (taped). Ten plots were in the control area, and the remainder in the treated area.

Data were collected by the students of Santa Rosa Jr. College NRM70 class, as a field exercise, as well as by the principal investigator. All data were collected within one month.

Data summary

Of the 77 saplings inventoried, 19 were in the control area, or 25 percent. This is notable, because the control represented 33 percent of the area observed (table 1). This is reflected in the saplings per acre values; treated saplings averaged 360 trees per acre, and control less than 240. For comparison, normal reforestation plantings range from 10 x10 foot spacing to 15 x 15 foot, values of 436 to 154 seedlings per acre (Arvola 1978).

There was little difference in distance to stump on both treated and control. Diameter and height, however, showed important trends, increasing on treated sites. Range of heights was highly variable, up to 4.57 m (15 ft). Diameters, however, were significantly different. Diameter averages were 2.46 and 1.37 cm (0.97 and 0.54 inches) for the treated and control sites, with standard deviations, respectively of 0.271 and 0.356. A t-test with these values is shown in fig. 2.

Table 1—Data summary

	Treated	Control
Redwood saplings (n)	58	19
Redwood saplings/acre (TPA)	360	236
Mean diameter (inch)	0.97	0.54
Mean height (ft)	4.6	3.7
Mean distance to tanoak (ft)	6.8	6.4

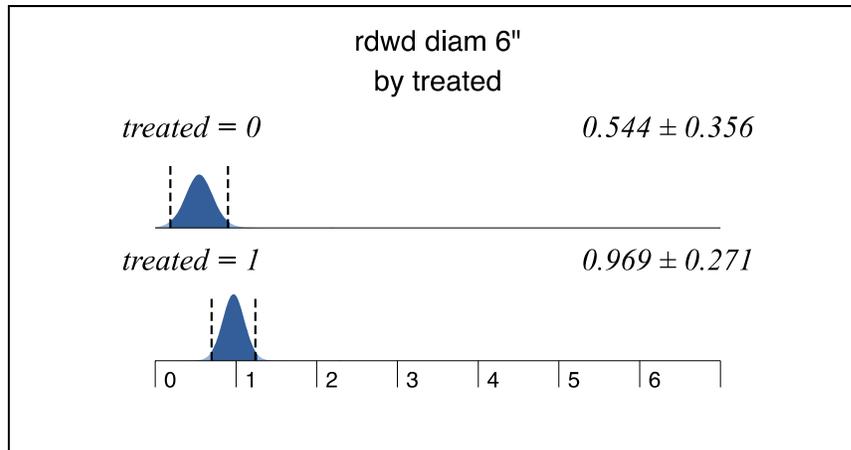


Figure 2—t-test of diameter (0 = Control, 1 = Treated) (inches). P = 0.093.

Hypothesis testing and results

Statistical testing found a very significant relationship between treatment and diameter of saplings with the Kolmogorov-Smirnov test ($p = 0.098$) and a significant relationship with the t-test ($p = 0.093$), not disproving the original hypothesis. Because diameter reflects actual growth and vigor of trees, and because the difference between control and treated was close to twofold, this result is notable. As stated above, saplings are presently 5 and 6 years in the ground. The increased diameter at this early age reflects root growth and, with it, the ability to compete for canopy co-dominance. Height and distance to dead tanoak were not significant. One factor which was not tested under the hypothesis, however, was an unusual finding. Two of the 10 plots (20 percent) in the control area had sapling damage from fallen tanoaks, as in fig 3. The fallen tanoaks bend the saplings down, creating uneconomic, suppressed and deformed trees. This damage is reflected in the lower trees per acre value (these trees were not counted). While this situation has not been tested statistically, any damaged redwood in this management regime represents a lost opportunity relative to forest production goals.



Figure 3—Tanoak debris damaging redwoods. (photo by author)

Conclusions and recommendations

Sudden oak death infestation on Bear Flat Tree Farm in Healdsburg, California is both promoting and interfering with the regrowth of coast redwoods. The mortality of tanoaks creates gaps in the canopy, allowing redwood and a suite of other species to grow rapidly. When redwoods are planted prior to the individual tanoak trees' death and in-situ decay, they are able to capture the site when it is subsequently thinned.

If the site is not thinned, there are two effects of the SOD passage. First, it promotes all species, capturing the increased water and sun. That suite of species, including resprouting tanoak, suppresses the newly established redwoods. This relationship has been explored in this study, showing that redwoods in thinned areas will have grown nearly twice as much just 2 years after the thinning, from an average of 1.37 cm (0.54 inches) diameter at 15.24 cm (6 inches) height (control) to 2.46 cm (0.97 inches) (treated).

The other effect of SOD is large woody debris damaging crop trees. The debris bends and stunts redwood saplings, affecting 20 percent of the control plots and reducing the trees per acre of redwood from 360 to 236. While the reduction in sapling frequency was not demonstrated to be significant in this study, the effect was nonetheless notable and of concern. To a forest manager, no crop tree is expendable.

The conclusion of this study is simple: SOD-affected tanoak stands must be managed for regrowth. The opportunity presented to the forest manager is important; tanoak has challenged site from redwood occupancy for many years. With SOD in the landscape, redwoods may now recapture sites without herbicides while maintaining a mixed species stand. The tools for guiding the mortality created by

SOD are planting and thinning. Actively managing the SOD may take several minor treatments in a stand because of the slow passage of the pathogen, but the results of lower redwood mortality and a much more vigorous stand are ideal.

Further research indicated by this study is evaluating the cost-effectiveness of thinning and planting in the SOD-affected forest. Forest managers would like to capture all space with crop trees, but that is never possible. How many entries are cost-effective for landowners of various classes to use? How much assistance is needed from the state or federal government to respond to spur landowners to conduct SOD response practices in the Redwood Region? Are existing cost-share programs adequate?

While questions linger over cost, there should be no hesitation for landowners to begin implementing a program as soon as SOD arrives. Identifying areas of infestation, finding suitable planting stock, and beginning a program of planting near susceptible trees is a start. Subsequent thinning will change the look, economics and ecology of the redwood forest.

Acknowledgments

This work was made possible by Santa Rosa Jr. College, the 2014 NRM 70 (Forest Practices) class, and the continuing work of Forest, Soil and Water staff and contractors, who manage the Bear Flat forest.

References

- Arvola, T.F. 1978. **California forestry handbook**. Sacramento: CA: State of California, California Department of Forestry. 232 p.
- Cobb, R.C. [and others]. 2013. **Biodiversity conservation in the face of a dramatic disease: an integrated strategy for tanoak (*Lithocarpus densiflorus*) threatened by sudden oak death**. *Madroño* 60(2): 151–164.
- Euphrat, F.; Mohr, A.; Sternberg, R. 2006. **Bear Flat NTMP. 1-NTMP-03 SON**. CalFire THP library.
- Garbelotto, M.; Schmidt, D.J.; Harnik, T.Y. 2007. **Phosphite injections and bark application of phosphite + pentrabark™ control sudden oak death in coast live oak**. *Arboriculture and Urban Forestry* 33(5): 309–317.
- Miller, V. 1972. **Soil survey of Sonoma County**. U.S. Government Printing Office, Washington, DC: U.S. Department of Agriculture, Forest Service and Soil Conservation Service. 311 p.
- Rantz, S.E. 1969. **Mean annual precipitation of the California Region, north half**. Menlo Park, CA: United States Geological Survey.