# Conditions 10 Years After Sudden Oak Death Suppression Treatments in Humboldt County, California[1]

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## Abstract

In 2006, three isolated sudden oak death- (SOD) infested locations within Humboldt County were selected for silvicultural treatments that targeted the removal and/or reduction of tanoak (*Notholithocarpus densiflorus* Hook. & Arn.) and California bay laurel (*Umbellularia californica* Hook. & Arn), the main hosts supporting sporulation of *Phytophthora ramorum* (Valachovic and others 2010). In these treatment areas, subsequent rates of infection on re-sprouting tanoak and bay laurel varied widely, but were very low where bay laurel was either absent or in low densities at the time of treatment. Additionally, infection rates were substantially lower in treated areas than in adjacent untreated ones (Valachovic and others 2013b). Ten years after the completion of these treatments, we examined some of the other effects at the treatment sites (fig. 1), particularly effects on fuel loading, tree regeneration, and shrub establishment (fig. 2), and reflect upon lessons learned.


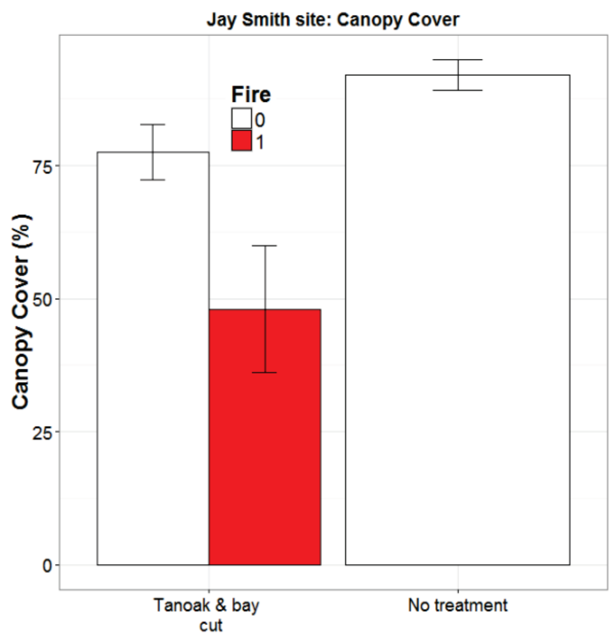


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Figure 1—Canopy cover differences as related to treatment type at the Jay Smith site. Treatments included removal of tanoak and California bay laurel with (1) and without (0) the addition of prescribed fire.

The treatments have resulted in differences in fuel loads and host tree regeneration between burned and unburned treatments, as well as between these treatments and an herbicide treatment targeting both California bay laurel and tanoak. The long-term effects following the cutting of tanoak and bay laurel host trees, plus prescribed fire, included fire-related mortality of large diameter Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) trees—probably conditioned by pre-existing site factors that gave these trees increased susceptibility to fire damage, insect and pathogen attack, and drought stress. This treatment also resulted in subsequent high densities of regenerating native and non-native shrub species (fig. 2). In contrast, in the unburned treatment areas, the treatment did not cause Douglas-fir mortality and gaps were re-populated mostly by re-sprouting tanoak and/or bay laurel. However, we note that regenerating bay laurel and tanoak stump sprouts have become infected by *P. ramorum* at fairly high rates across one of the sites, suggesting that this species may support re-invasion by the pathogen even after treatment. The density of bay laurel stump sprout clumps, saplings, and trees surrounding a given stump sprout clump is significantly related to its infection rate, and infection rates were much lower on 2-yr-old sprouts (cut manually 5 years after treatment) than 7-yr-old ones (fig. 3).

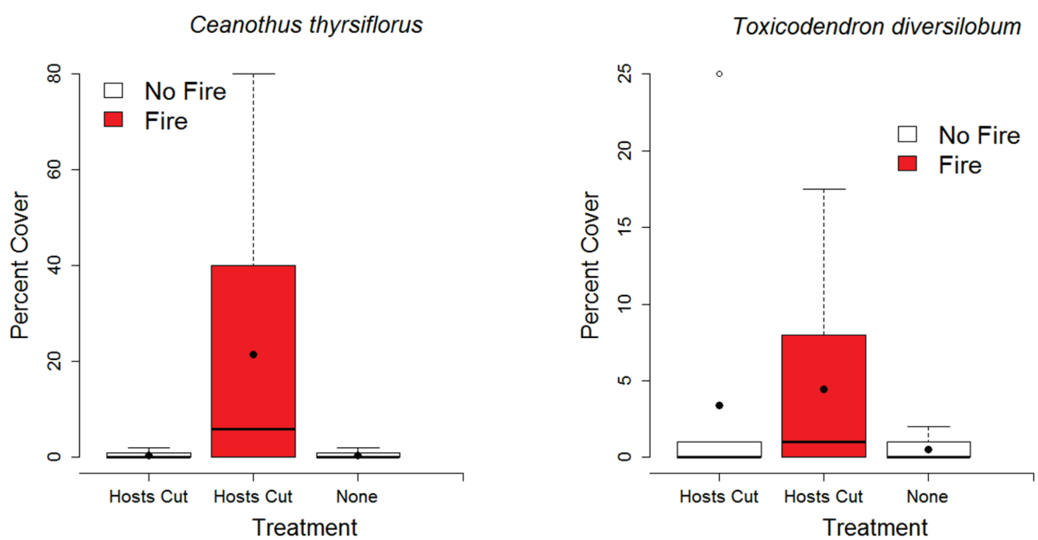


Figure 2—Changes in canopy cover, plus the addition of the prescribed fire at the Jay Smith site, stimulated *Ceanothus thyrsiflorus* and *Toxicodendron diversilobum*. Boxplots with mean shown as black dot.

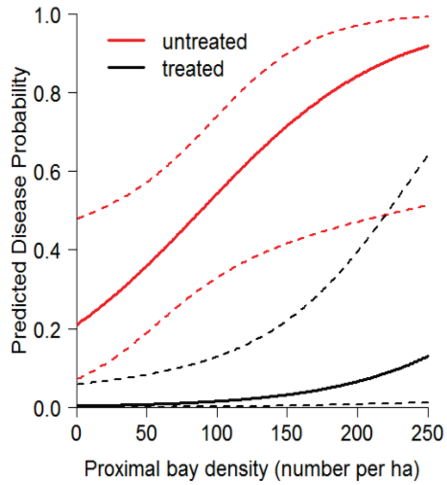


Figure 3- The relationship between probability of a sprout clump becoming infected and density of proximal bay laurel individuals (stump sprout clump, sapling, or trees). Black lines represent the sprouting bay stumps from the 2006 treatments that were cut again in 2011; red lines represent sprouting bay stumps with no further treatment since the 2006 treatment. Dashed lines represent 95% confidence intervals around the predicted probability of disease.

Fine woody debris, coarse woody debris, and duff and litter depth (measured by Brown's Transects) showed some differences among treatments. While coarse woody debris was not significantly different among treatments, the amount of coarse woody debris of broadleaf species (tanoak, bay, and madrone) at the Jay Smith site in 2016 was significantly related to the basal area cut in the treatments ($p=0.00013$; $R^2=0.64$; fig. 4a). Duff depth in the treatment with prescribed fire after cutting of hosts at Jay Smith was still significantly lower in 2016 than the other two treatments (Analysis of Variance with Bonferroni-adjusted comparisons; $p < 0.0001$; fig. 4b); a similar pattern was seen with litter depth (data not shown).

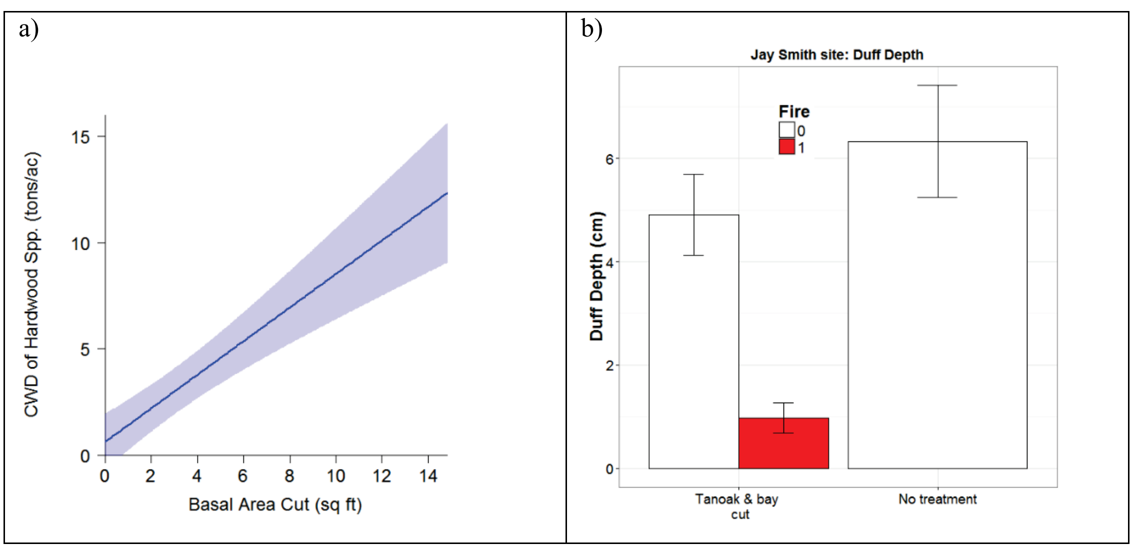


Figure 4—a) Coarse woody debris of hardwood species vs. basal area cut in treatment (with 95% confidence interval); b) duff depth by treatment.

The results of these studies are useful to inform future disease suppression treatments. Managers should be aware of the need for follow-up treatment to manage potential impacts triggered by disease suppression efforts (Valachovic and others 2013a). Future research using multiple rounds of fire to provide such follow-up treatments is needed. Additionally, results highlight the necessity to carefully evaluate potential tree-stressing environmental factors that could be exacerbated by disease management treatments. Treatments for sudden oak death, as with any treatment for pest management, should be conducted within a context of long-term forest development and forest management goals.

## Literature Cited

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