# Is Stump Sprout Treatment Necessary to Effectively Control *Phytophthora ramorum* in California's Wildlands?[1]

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### Abstract

In California, wildland hosts that support sporulation of *Phytophthora ramorum*, such as California bay laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.) and tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh), also develop prolific basal sprouts following mortality, injury, or tree harvest. Assessing long-term silvicultural treatment effectiveness for *P. ramorum* control is complicated by this stimulation of basal sprouting following tree removals. To better design *P. ramorum* treatments, we need to know how sprouts regenerating from cut host tree stumps are involved in local persistence of *P. ramorum*. These sprouts could act as reservoirs to maintain inoculum levels as forests regenerate and/or serve as points of re-invasion from vegetation surrounding treatment areas.

Following host tree removal treatments of infested stands in 2006, stump sprouts showed little infection for at least 3 years, suggesting that younger sprouts were less likely to become infected, or that climate was perhaps simply not suitable for the pathogen during these initial years, or both. To help clarify these issues and determine whether manual removal of sprouts after host tree removal is necessary to control pathogen persistence and reestablishment, we established two different sprout cohorts alongside each other in 2011 in areas at three sites where hosts were removed in 2006.

One year after we established this study, it appears that California bay laurel sprouts that were manually cut in 2011 were less likely to be infected than nearby untreated sprouts that had grown for 7 years. Tanoak sprouts manually cut in 2011, on the other hand, show similar infection rates to nearby tanoak sprouts that were left uncut. At two of the sites, infection rates on both treated and untreated tanoak stump sprouts in 2012 have remained low, similar to pre-treatment levels. However, the other site presented high-infection rates in 2011 on tanoak, and both tanoak sprouts re-growing after cutting in 2011 and their 7-year-old paired sprouts were infected in 2012.


*Key words*: *Phytophthora ramorum*, sudden oak death, sporulation, stump sprout treatment

## Introduction

Little is known about the role that stump sprouts of tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh) and California bay laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.) play in allowing *Phytophthora ramorum* to persist or re-invade stands that have been treated by silvicultural methods. In southern Oregon, where a long-term effort has been made to eradicate the pathogen from the region of infestation, standard protocol has included use of herbicide on sporulation-supporting hosts prior to cutting; this controls the sprouting response (Kanaskie et al. 2008). This protocol was initiated because of observation of infected stump sprouts from the treated stumps; 38 out of 43 sprout clumps sampled after initial treatment and resprouting displayed foliar symptoms (Hansen et al. 2006).

*Phytophthora ramorum* infestations in Humboldt County occur on small private parcels, industrial

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ownerships, as well as a variety of public land types- each with distinct goals and management interest. Landowners vary in their interest in using herbicides to control stump sprouting and because of this, a better understanding of the role of stump sprouts have in pathogen persistence, re-invasion, and spread dynamics is needed. Manual control of sprouts is an option, but this requires considerable labor, and for many it is unfeasible.

In 2006 a series of treatments were installed to control *P. ramorum* from a variety of forest types in Humboldt County. In these treatments infected tanoak and California bay laurel were removed by chainsaw without herbicide application to control sprouting. The sprouts of these stumps were used as a bioassay to monitor potential re-establishment of *P. ramorum* over time (Valachovic et al., Suppression of *Phytophthora ramorum* infestations through silvicultural treatment in California's north coast, this Proceedings). Based on presence of symptoms at these tree removal treatment units, less than 10 percent of stump sprout materials had become infected by 2010 (4 years post-treatment). This symptom-based approach likely overestimates the actual infection rate, since only about 33 percent of symptomatic individuals actually yielded the pathogen in culture during 5 years of post-treatment monitoring. This low incidence of pathogen reestablishment in treated units occurred despite rapidly rising levels of infection in areas surrounding the treatment units (about 30 percent of plots in adjacent untreated areas had *P. ram*orum confirmed) by summer 2010. This suggested that young stump sprouts were either more resistant to becoming infected or that relatively low amounts of spring rainfall in 2007 through 2009 did not provide favorable conditions for *P. ramorum* to re-invade into the treatment units, particularly given that treatments likely produced drier microclimates in these stands.

## Methods

In 2011 a secondary treatment was added to *P. ramorum* suppression management units that were established in 2006 on three sites in southern Humboldt County, California: "Connick Creek," "Jay Smith," and "Salmon Creek" (Valachovic et al., Suppression of *Phytophthora ramorum* infestations through silvicultural treatment in California's north coast, this Proceedings). In these treatment units where California bay laurel and tanoak were removed (one unit per site), pairs of stump sprouts were randomly selected from the peripheries of 0.04 ha (0.1 ac) permanent circular plots used to monitor the treatments; each stump sprout group within each pair was randomly assigned to either being untreated or having all stems manually cut (treated). At Connick Creek, 19 pairs of tanoak stump sprouts were selected, but California bay laurel was not included because of its paucity in the tree removal treatment unit. At Jay Smith, 15 tanoak and 20 California bay laurel sprout pairs were chosen. Five pairs of each species were selected at Salmon Creek. At this latter site, the only unit available was one in which only a thinning of infected hosts was completed in 2006 (and in many respects serves as a partially treated control because of the high number of uncut infected trees left to impact the site, as compared to the two other sites where treatment was thorough); complete removal of tanoak and bay laurel was conducted at the other two sites.

We examined stump sprouts for symptoms and sampled tissues where *P. ramorum* symptoms were present. This was done prior to the sprout cutting treatment in 2011 and again 1 year later. We plated symptomatic tissues on PARP media for isolation of *Phytophthora* spp.

## Results and Discussion

At the time that the stump sprout pairs were established in 2011, infection levels varied among sites and by 2012 showed some interesting patterns following the creation of a new age cohort of sprouts. At Salmon Creek, 80 percent of selected California bay laurel and tanoak stump sprouts were infected in 2011 and in 2012, every tanoak individual of both untreated stump sprouts and one-year-old (treated) sprouts was infected. This is in contrast to the patterns observed at the Connick Creek site, where infection levels were initially low (10 percent or less) for tanoak. Infection levels were also low for both tanoak and California bay laurel at Jay Smith. However, while infections were observed on 80 percent of the untreated California bay laurel sprouts at Salmon Creek in 2012, none of the treated California bay laurel sprouts were infected in the same year. A similar pattern was seen at Jay Smith with California bay laurel, where infection levels were observed on 50 percent of untreated sprouts, but were observed on only at 10 percent of treated sprouts (fig. 1). Infection rates of tanoak sprouts remained low at Connick Creek and Jay Smith. Untreated California bay laurel sprouts averaged over 4.6 m (15 ft) tall by 2012 at Jay Smith.

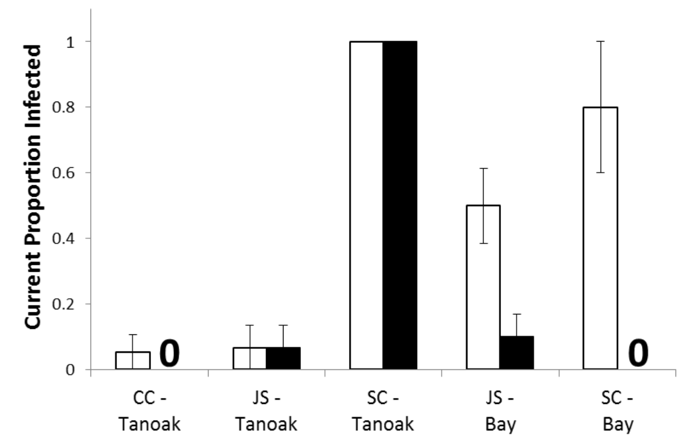


Figure 1—Proportion of stump sprouts infected by *Phytophthora ramorum* in 2012. Untreated–unfilled bars; cut in 2011–black-filled bars. Error bars plus/minus 1 SEM. Site names designated by first letter each of two-word names.

At the Salmon Creek site, the presence of infected mature California bay laurel and tanoak apparently resulted in high enough inoculum pressure that 1-year-old tanoak stump sprouts became heavily infected. We will need to monitor tanoak stump sprouts at other sites for a longer period, until more individuals become infected, to judge whether or not the age of these sprouts makes a difference to their susceptibility in units where inoculum pressure is lower due to absence of mature, sporulation-supporting hosts. On the other hand, our results to date suggest that younger California bay laurel stump sprouts are less likely to become infected than older ones. This pattern was strong at both the Salmon Creek site, where inoculum pressure was relatively high, and at Jay Smith, where low infection levels of tanoak stump sprouts in both cohorts suggest relatively low inoculum pressure. These results suggest that regular re-treatment of bay laurel sprouts may be warranted, although it may not be immediately necessary at the time of silvicultural treatments. At this time, however, data are preliminary, as this study is ongoing and requires a longer monitoring period to evaluate treatment effectiveness. We are collecting data on microclimate, weather variables, and sprout clump size, and we will examine their effects on infection rates in the future.

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