

Assessing Methods to Protect Susceptible Oak and Tanoak Stands from Sudden Oak Death

Tedmund J. Swiecki¹ and Elizabeth Bernhardt¹

¹Phytosphere Research, 1027 Davis Street, Vacaville, CA 95687, USA

Corresponding author: phytosphere@phytosphere.com

Landowners and managers have been seeking ways to protect susceptible oak species and tanoak from sudden oak death (SOD) caused by *Phytophthora ramorum*. Because disease epidemiology differs between tanoaks and susceptible oaks, we are testing different control strategies appropriate for different forest types. The disease management studies described here are intended to test whether various management techniques will be effective when applied in the field at the stand scale.

In tanoak (*Lithocarpus densiflorus*) stands, we are testing applications of potassium phosphite (Agri-FosTM) in contiguous blocks of trees ranging from about 250 m² to 1.3 ha. Our initial study plots were established in December 2005 in Sonoma County; the most recent and largest plots were established in San Mateo County in 2007 and 2008. In all plots, we have used bark spray applications (Agri-FosTM diluted 1:1 with water + 2.5 percent PentrabarkTM surfactant by volume) with rates scaled to stem cross-sectional area (figure 1). The curve is linear for stems up to 30.5 cm DBH. For larger stems, the curve uses a quadratic formula to deliver a more constant dose of phosphite per unit volume of sapwood (Swiecki and Bernhardt 2007). We also shifted the application zone higher on the stem (up to 6 m height) to enhance uptake. Agri-FosTM has been applied to trees in treated plots twice in the first year with a six month retreatment interval and with a 12 month retreatment interval thereafter. At one location, stem injection applications using two different injection systems were added for comparison purposes in 2008.

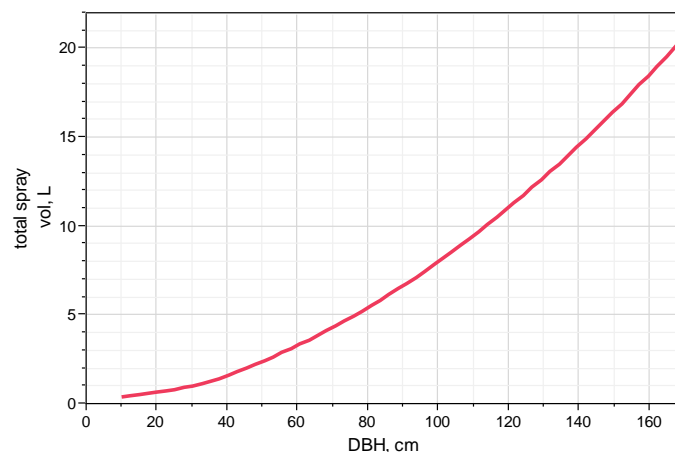


Figure 1. Curve showing volumes of diluted Agri-FosTM spray solution used for stems of varying diameters.

Most plots did not contain any California bay (*Umbellularia californica*). In the few plots where small bay trees or saplings were present, they were removed at the time that plots were established. In all sprayed plots and matched control plots (thinned controls), small diameter tanoaks stems (generally <5 cm DBH) were also removed prior to treatment. These small stems are difficult to treat and evaluate for disease due to foliar phytotoxicity from the phosphite/surfactant spray solution. In two locations where we removed a significant amount of understory tanoak, we set up a second control plot (nonthinned control) with no understory

tanoak removal. The plots without understory tanoak removal are included as a check to determine whether removal of understory tanoaks alone can affect disease development within the plot.

To date, SOD-affected trees are lacking or occur at very low percentages in all but the oldest plots, where no significant differences due to treatment have yet been detected. SOD incidence ranges from 2 to 27 percent in these plots (table 1). Most of these infections were likely initiated in the last two wet spring seasons, 2005 (prior to treatment) and 2006 (after the initial application). Monitoring conducted in plots in spring 2007, 2008, and 2009 failed to detect *P. ramorum* inoculum, indicating that disease pressure has been very low for the past three years.

Table 1. SOD incidence and mortality of tanoak stems attributed to *P. ramorum* and other factors observed 42 months after initial treatment in December 2005. Plots are located in northwest Sonoma County. Thinning refers to removal of small understory tanoak.

Location	Plot	Treatment	Live stems at start of study	Percent of stems with likely <i>P. ramorum</i> canker	Percent overall mortality	Percent mortality attributed to <i>P. ramorum</i>
BL	BL3	Agri-Fos+thin	57	1.8	1.8	0
	BL4	thinned control	57	1.8	7.0	1.8
	BL5	nonthinned control	56	7.1	5.4	5.4
SF	SF1	Agri-Fos+thin	63	27	14.3	12.7
	SF2	thinned control	61	13.1	1.6	1.6
	SF6	nonthinned control	72	16.7*	8.3	8.3

*Three percent of stems in this plot were symptomatic at the start of the study.

In oak stands, where California bay is the primary source of *P. ramorum* inoculum, we are testing local and area-wide removal of bay near susceptible coast live (*Quercus agrifolia*, California black (*Q. kelloggii*), and Shreve oak (*Q. parvula* var. *shrevii*) as a disease management technique. At one location with high value coast live oaks along a seasonal creek, bay removal is being combined with phosphite application (by spray or injection) because the extent of bay removal was limited due to other management considerations.

We established plots to study bay removal in localized zones around individual oaks (minimum bay foliage to oak trunk clearance=2.5 m) at five locations in Sonoma, Napa, and Solano Counties in 2007. At each site, bay neighborhoods around oaks and oak disease status were assessed prior to treatment. We identified 49 matched pairs of trees with similar bay neighborhoods and then removed bay around one member of each pair, leaving the untreated member as a control. Bay neighborhoods were reassessed immediately after treatment and annually thereafter. To date, due to low inoculum pressure associated with drought conditions, no differences have developed between treated and untreated plots.

In two locations in San Mateo County we initiated studies of area-wide removal of all bay within patches as large as 2.75 ha in 2009. Control plots without bay removal were established adjacent to the treated plots. Bay neighborhoods and disease status for a sample of the oaks in each plot were assessed prior to treatment. Bay neighborhoods in the treated plot were reassessed shortly after bay removal was completed.

Sprout regrowth from cut bay stumps has not been very vigorous in the first year after cutting, especially in relatively dry sites. Evaluations in June 2008 showed that browsing by deer and other animals was highly effective at reducing bay sprout growth. More than a year after the initial bay removal, the tallest bay stump sprout was 1.3 m, but shoots over 0.8 m were seen at only one of the study locations where browsing was limited. The remaining locations had average maximum bay sprouts heights of 37 cm or less. Basal diameters of sprouts averaged about 0.78 cm and were easily removed using loppers or an axe. In addition, very few of the pruning cuts made to remove bay branches from larger stems gave rise to epicormic sprouts. At the two San Mateo locations, stumps were sprayed with glyphosate (20.5 percent) immediately after cutting to suppress sprout growth. By 6 months after treatment, sprouts were lacking on almost all treated stumps.

Continued monitoring is needed to determine the efficacy of both phosphite and bay removal treatments. However, these studies show that it is feasible to implement these disease management methods at various spatial scales to protect tanoaks and oaks from SOD.

Literature Cited

Swiecki, T. J. and Bernhardt, E. A. 2007. Management of *Phytophthora ramorum* in tanoak and oak stands, Forest Service Agreement No. 06-JV-11272138-040, Progress report 3 - 12/31/07. Available: http://phytosphere.com/publications/Dec2007_Progress_report_06-JV-040_SOD_mgmt.pdf

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