Management of *Phytophthora ramorum* in tanoak and oak stands

Forest Service Agreement No. 06-JV-11272138-040

Progress report #3 - 12/31/07

This progress report updates report #2 which was issued June 30, 2007. Major areas of work over the last 6 months include choosing study trees, collecting baseline data, and conducting bay removal at 9 new pairs of oaks on the Anderson property. The Garbelotto lab decided to defer sampling of tanoak twigs from Agri-fos® treated plots until spring, so that project activity was deferred. Ted Swiecki gave a presentation on sudden oak death for Green Valley homeowners (Solano County).

Introduction

The objective of this study is to test methods for managing *Phytophthora ramorum* canker in tanoak and oak stands. Because disease epidemiology differs between different canker hosts, we are testing different control strategies in tanoaks and susceptible oaks. For tanoak, we are studying the use of potassium phosphite (Agri-fos®) applied as a protectant spray. For coast live oak and California black oak, we are testing whether localized bay removal and/or pruning will reduce the risk of *P. ramorum* infection to acceptably low levels. The tanoak / phosphite portion of the study is being conducted in collaboration with Matteo Garbelotto and Yana Valachovic. The long term plots we have established for this project are located in Napa and Sonoma counties.

We posted a synopsis of the study on our website (http://phytosphere.com/publications/SODmanagementstudy.htm) that was originally used to provide information for potential cooperators. This page has been updated to reflect the current status of the study and share information on project progress with our cooperators and other interested parties. Other websites have cited information from this page, so it appears that this information has been reaching the intended audience.

Objective 1. Protection of tanoak stands using bark-band application of phosphite and understory thinning.

The Phytosphere tanoak/phosphite plots are summarized in Table 1-1 below. The 12 plots have 679 tanoak stems which are being individually tracked. The number of stems in each plot is shown in Table 1-2.

The plots established in cooperation with the Kashia Band of Pomo Indians of Stewarts Point Rancheria are handled under a separate contract with the Kashia. Funding for that project is provided by USDA-FS State and Private Forestry.

The treated plot on the PC property was sprayed with Agri-fos® on 1/29/07 with the help of Reno Franklin, Walter Antone, and Wanda Borgo, using the Kashia tribe ATV mounted sprayer. On 2/1/07, Kamyar Aram of Dave Rizzo's lab helped us spray the two treated plots on the FE property, using a bicycle-mounted Shurflo Propack™ sprayer. The plots received a second application of Agri-fos in May 2007. The FE plots were retreated using the bicycle-mounted sprayer with the help of Chris Perry (former SOD coordinator for Sonoma County) on 5/24/2007. We retreated the PC plots using the bicycle-mounted sprayer on 5/29/2007.

At this point, both the earlier set of plots (established in 2005/2006) and the more recently established plots (2007) have been treated using the same spraying schedule. The Kashia set of plots was retreated in May 2007 following the original plan to reapply Agri-fos® at annual intervals.

Table 1-1. Overview of tanoak phosphite-treated and control plots.

Property name	Locality	Plots	Agri-fos applications	Notes
SF	Seaview Ranch	1 Agrifos treated+thinned 1 thinned control 1 nonthinned control	Dec 2005 May 2006 May 2007	Plots initially established 2005 (Kashia tribe cooperating).
BL	Gualala Ranch	1 Agrifos treated+thinned 1 thinned control 1 nonthinned control	Dec 2005 May 2006 May 2007	Plots initially established 2005 (Kashia tribe cooperating).
PC	Gualala Ranch	1 Agrifos treated 1 control	Jan 2007 May 2007	Understory tanoak mostly pre-thinned by landowner. Some minor additional thinning was conducted in treated and nontreated plots.
FE	Mill Creek Road	2 Agrifos treated 2 control	Feb 2007 May 2007	Understory tanoak mostly pre-thinned by landowner. Some minor additional thinning was conducted in treated and nontreated plots

We have endeavored to be relatively precise with respect to the amount of phosphite applied to each stem so that variation in phosphite dose not constitute a large source of unexplained variation. Due to a lack of published information on the amount of spray to use on trees of various diameters, we had to develop equations to relate tree diameter to spray volume. The process we used is described in the section below which is excerpted from a progress report sent to the Kashia Band in Dec 2006.

Table 1-2. Number of tanoak stems in each plot

Property name		Treatment /Number of stems		
	Plot	Agrifos+thin	Thinned control	Nonthinned control
BL	BL3	58		
	BL4		59	
	BL5			58
FE	FE1	39		
	FE2		33	
	FE3	41		
	FE4		50	
PC	PC1		75	
	PC2	75		
SF	SF1	63		
	SF2		61	
	SF6			72
TOTALS		276	278	130

Phosphite application volume calculations

In order to apply phosphite at a consistent rate and to be able to calculate the amount needed prior to application, we needed to establish a relationship between tree size (DBH) and spray volume. We contacted William Stringfellow, the technical representative for Agri-fos, to determine what diameter-volume relationships existed, since the pesticide label gives no specific guidance in this regard. The guidelines provided by Mr. Stringfellow are summarized in Table 1-3 and Figure 1-1 below.

These rates had to be interpolated and extrapolated for other tree diameters. However, the values are nonlinear when plotted and the relationship between tree diameter and spray volume could be approximated in several ways, including a line, a series of lines (step function) or a quadratic function (Figure 1-1).

Table 1-3. Spray volume guidelines for Agri-fos bark spray application to trees of different diameters and bark roughness.

Tree DBH, inches	Spray volume (gal)	
	Smooth bark	Rough bark
6	0.125	
12	0.25	
18	0.5	0.63
24	0.63	0.75

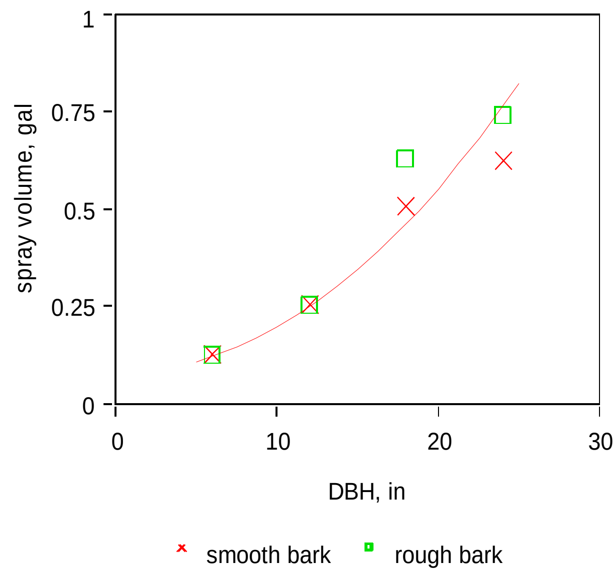

Figure 1-1. Graph of spray volume guidelines for Agri-fos bark spray application to trees of different diameters and bark roughness. Red line represents fitted quadratic function.

Phosphite moves systemically within plants, and the tissue concentration of phosphite has been shown to be related to restricting the development of *Phytophthora* lesions (Jackson and others 2000). To attain effective concentrations of phosphite within tanoak stem tissues, we assumed that the volume of the outer stem tissues needs to be taken into account rather than simply the stem diameter. Although stem diameter (DBH) and bark surface area are linearly related, the volume of the stem is related to the square of the diameter (Figure 1-2). Because of this relationship, as stem diameter increases, the ratio of bark surface area to bark/sapwood volume decreases (Fig 1-3). In other words, there is more bark-sapwood volume per unit of outer bark area in larger trees than in smaller trees. If application rates are based on a linear relationship between stem diameter and spray volume, the amount of phosphite applied per unit of bark/sapwood volume will decrease as stem diameter increases. As a result, tissue concentrations of phosphite are likely to decrease as stem diameter increases, which would presumably lead to poorer disease control in larger-diameter trees.

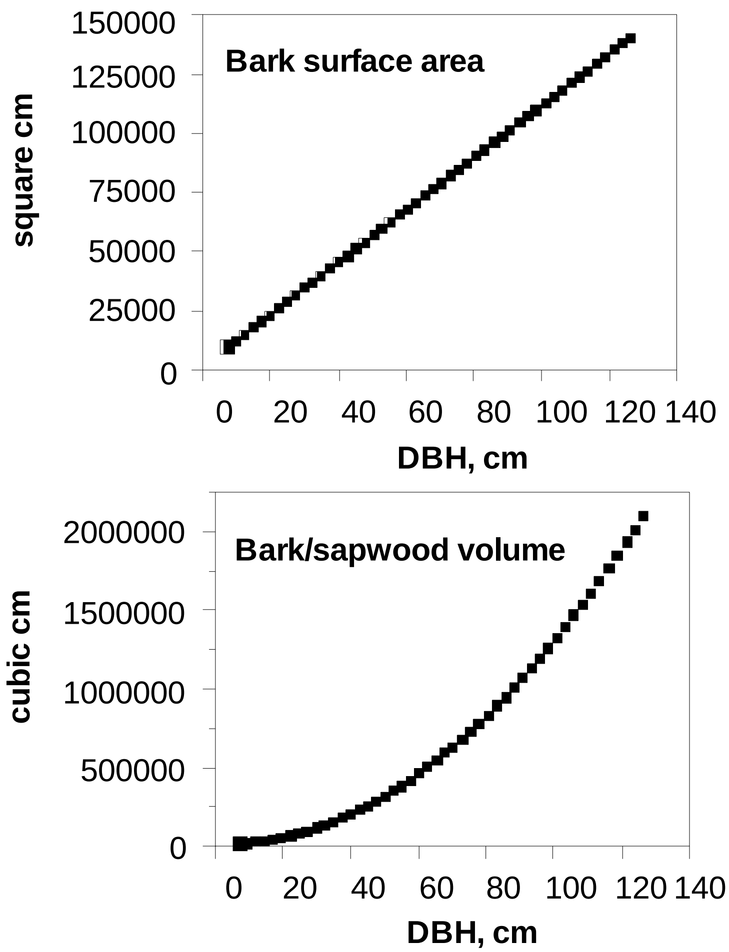

Figure 1-2. Relationships between trunk DBH and bark surface area (upper graph) and the bark-sapwood volume to a depth of 5 cm from the outer bark surface (lower graph).

Based on these calculations, we concluded that if the amount of applied spray volume were related to the volume of the bark and outer sapwood, it would provide more constant phosphite concentrations across a range of stem diameters than would be achieved through a simple linear relationship between spray volume and stem diameter. However, stems have a limited ability to adsorb and retain spray solution before it runs off the surface, so this factor has to be considered as well.

To develop a generalized function for relating tree diameter to a constant ratio of spray volume per unit stem volume, we created a uniform distribution of tree diameters from 3 to 50 inches. We then calculated the surface area of these stems and the stem volume to a depth of 5 cm for the lower 3.5 m of the stem. Stem surface areas and volumes were calculated assuming that each tree was shaped like a cone frustrum in which the upper stem radius was 75% that of the lower radius. This taper was estimated empirically by measuring digital images of tanoak stems in the plots.

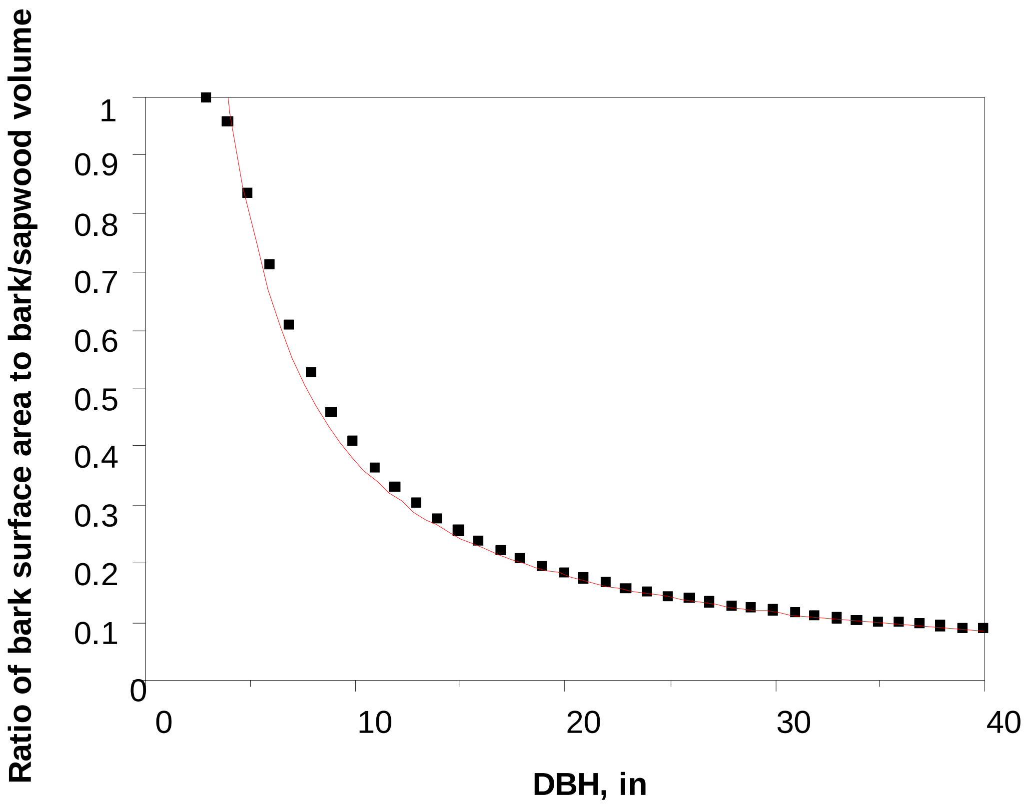

Figure 1-3. The relationship between stem DBH and the ratio between the stem surface area and bark/sapwood volume to a depth of 5 cm for the lower 3.5 m of the stem. Assumptions used in the calculations are noted in the text.

We used simple linear and quadratic functions fitted to the spray volumes listed in Table 2-2 to calculate the spray volumes that would be applied to a uniform distribution of tanoaks ranging from 3 to 50 inches (7.6 to 127 cm) DBH. The calculated mean spray volume per unit trunk volume for the entire diameter range was similar for the all calculated functions, and ranged from 0.00795 to 0.00946 ml spray/ml trunk volume.

Selecting a constant ratio of 0.00833 ml/ml across the range of tree diameters, the resulting equation that relates spray volume to DBH is:

$$\text{spray vol (gal)} = -1.349806 + 0.0969932\ [\text{DBH, in}] + 0.0019508\ ([\text{DBH, in}]-26.5)^2 \quad \text{(Equation 1)}$$

Compared with a simple linear model based on the data in Table 2-2, this quadratic formula would result in slightly lower spray volumes on small-diameter trees and much higher spray volumes on large-diameter trees.

The final equations used to calculated spray volumes for each treated stem were a compromise between the linear and quadratic models. For stems up to 30.5 cm (12 inches) DBH, we used a simple linear model based on the volumes in Table 2-1:

$$\text{spray vol (gal)} = 0.020833\ [\text{DBH, in}] \quad \text{(Equation 2)}$$

This spray volume results in the application of about 24 g active ingredient per inch of DBH or 9.4 g active ingredient (6 g phosphorous acid equivalent) per cm DBH at each application.

For trees greater than 12 inches DBH, we averaged the values obtained from Equation 1 with a linear model based on two of the coordinates from Table 2-1 (12 inches, 0.25 gal and 24 inches, 0.75 gal). The linear model for that portion of the DBH range is :

$$\text{spray vol (gal)} = (-0.25) + 0.0416667[\text{DBH, in}] \qquad \text{(Equation 3)}$$

The final equation for stems greater than 12 inches DBH is:

$$\text{spray vol (gal)} = -1.082772 + 0.0790841\,[\text{DBH, in}] + 0.0009754\,([\text{DBH, in}]-31.5)^2 \qquad \text{(Equation 4)}$$

Figure 2-4 shows the relationship between stem DBH and spray volume that results from using Equation 2 for stems up to 12 inches DBH and Equation 4 for larger stems. As shown in Figure 2-5, this compromise does not maintain a constant spray volume:stem volume ratio, especially for small diameter stems, but the ratio approaches a constant value more rapidly than is the case for a linear model (compare to Figure 2-3).

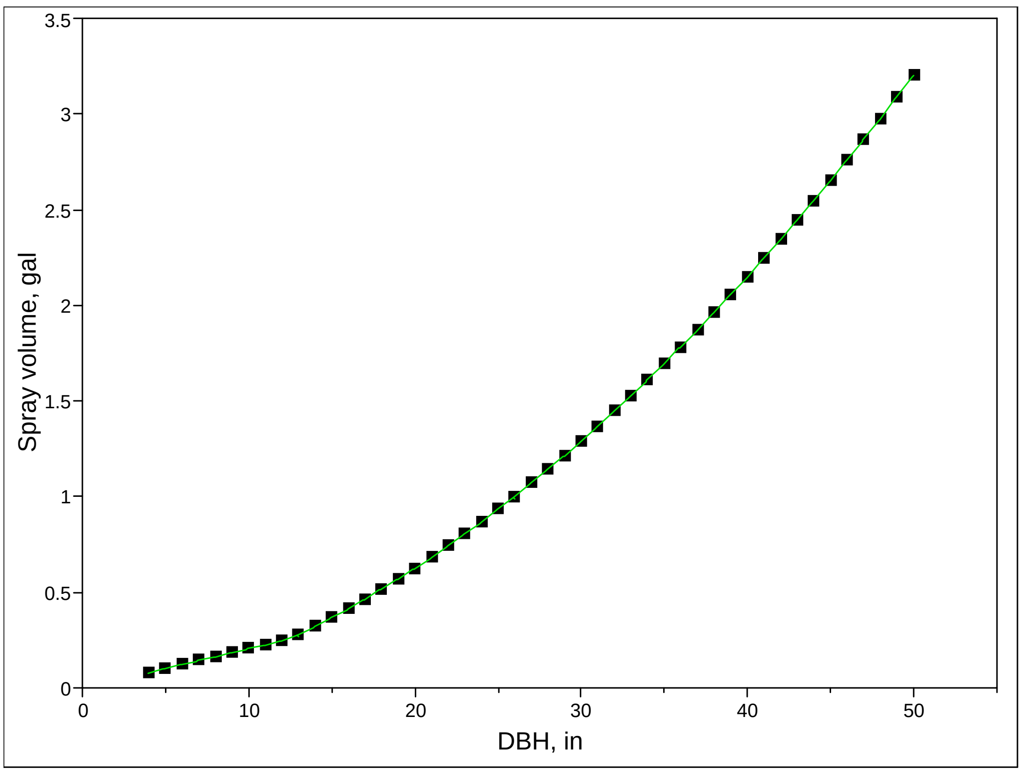

Figure 1-4. Overall curve showing Agri-fos spray volumes used for stems of varying diameters. The curve is based on Equation 1 for stems up to 12 inches DBH and Equation 4 for larger stems.

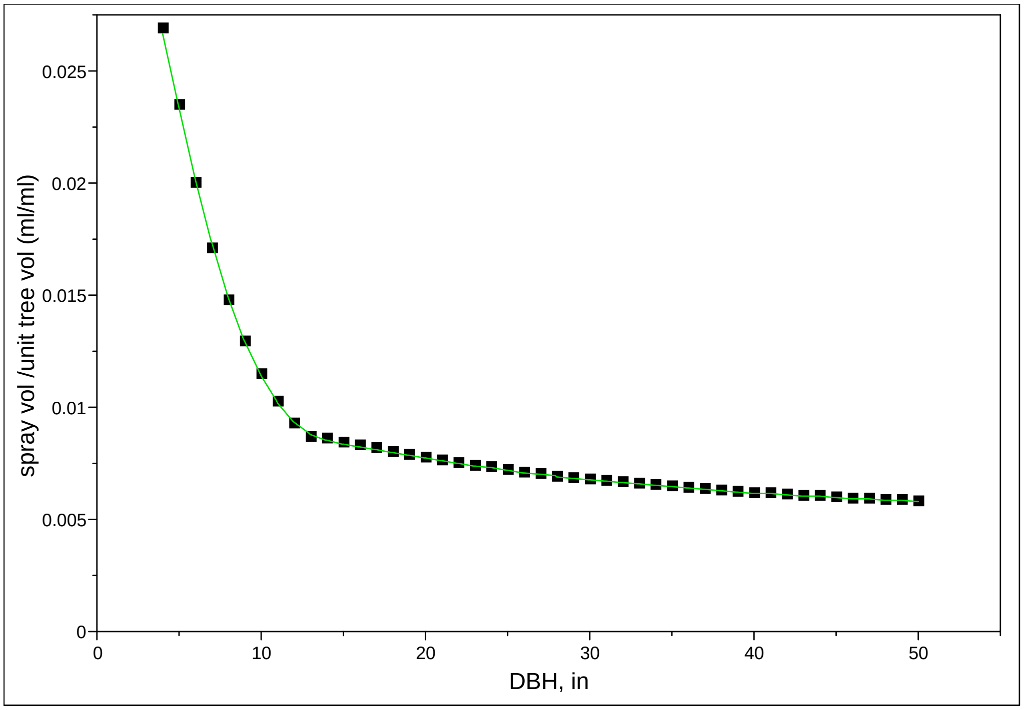

Figure 1-5. Relationship between stem DBH and the ratio between the stem surface area and stem volume to a depth of 5 cm for the lower 3.5 m of the stem. Assumptions used in the calculations are noted in the text.

To apply the target volumes to the stems, we first calculated the amount of spray volume needed based on measured stem diameters and then calculated the amount of time needed to spray the target volume from a calibrated spray boom. A stopwatch was used to time the application time for each stem.

Phosphite was applied as an aqueous solution of Agri-fos® (mono- and di-potassium salts of phophorous acid) systemic fungicide mixed with Pentra-bark® surfactant (2.5% by volume) according to label instructions for control of sudden oak death. To maximize the opportunity for phosphite uptake, we banded the spray high on the stem (3 to 6 m height). This high bark application provides two main advantages that should increase phosphite uptake:

1. Material is applied where the bark is thinner (and more permeable) and generally less densely coated with mosses that may absorb and tie up the phosphite.

2. As the residue is remobilized by rain, it has additional opportunities to be absorbed in the lower portion of the stem rather than being washed into the soil.

Phosphite spray solution was applied using a customized telescoping spray wand we developed for this use (Figure 2-6). The wand consisted of a lightweight aluminum pole that extended to about 4.25 m (14 ft). We mounted two parallel TeeJet® air induction nozzles (AIUB03VS) on the wand tip. One of the two nozzles is turned off when spraying small diameter trees that would have an excessively short spray time using the higher (2 nozzle) flow rate.

We have used two different sprayers. For applications done in conjunction with the Kashia, the spray boom is connected to an ATV-mounted sprayer with a 12 V pump which was calibrated to deliver about 30 ml/s when using both nozzles and 15.4 ml/s when using one nozzle. The ATV sprayer tank capacity is about 95 L (25 gal). The ATV sprayer is best used in sites that are not especially steep and that have a fairly open understory. The other sprayer we have used is a Shurflo Propack™ electric backpack sprayer. The pump on this sprayer has four fixed flow settings. We normally use the second flow setting with one nozzle (delivers 13.9 ml/s) for low volume applications and the third flow setting with two nozzles (delivers 23.9 ml/s) for higher volume applications. The Shurflo Propack™ sprayer holds 15 L (4 gal) of spray solution and is mounted on a modified mountain bike. This sprayer setup can be used on much steeper terrain and in less open stands than the ATV sprayer. The bicycle can be loaded with more weight than can be carried by one person: we typically load it up to about 73 kg (160 lb). However, a bike loaded to this degree is difficult to push up steep slopes, and is best managed by two people.

Application amount and cost. To treat all 256 stems in the 5 sprayed plots described above required 148 L of spray solution. This volume of spray solution contains about 72 L of Agri-fos and 3.7 L of Pentra-bark. The average diameter (DBH) of all stems in the treated plots was 17 cm, with a range from about 8 to 89 cm. The spray volume used per stem was modest for small diameter trees (e.g., about 473 ml for a 15 cm diameter stem). However, for larger stems, the spray volume was much more substantial because the spray volume curve we used (Figure 2-4) was calculated by averaging the linear rate based on stem surface area and power curve rate based on stem volume. For a 76 cm stem, the spray volume applied would be 4.9 L. This is more than 10 times the volume applied to the 15 cm stem, even though the diameter is only 5 times that of the smaller stem.

Put another way, 5 gal of mixed spray solution would treat about 40 stems 15 cm in diameter, but would be a bit short of the amount needed to treat four 76 cm diameter stems. At current full retail prices for Agri-fos and Pentra-bark (variable, but about $200 for 5 gal of mixed spray solution=2.5 gal Agri-fos and 1pint Pentra-bark) the cost of materials alone for each stem would range from about $5 (15 cm stem) to over $50 (76 cm stem) for each application. If the chemicals can be purchased at closer to wholesale cost, the cost of spray material per tree can be substantially lower, between one fifth and one tenth of the full retail cost.

Inoculum monitoring in plots. During the spring of 2007, we monitored inoculum production within the plots using buckets containing bay leaf baits. The protocol was developed by Steve Swain in Matteo Garbelotto's lab at UC Berkeley. The bay leaves used for baiting were collected in Vacaville. We had previously sent a sample of these leaves to the Garbelotto lab to ensure that they were susceptible to *P. ramorum* infection.

Four buckets containing bay leaf baits were even spaced within each plot. Each bucket contained 5 bay leaves attached to a styrofoam float and about 1 L of water. After 3 weeks we removed the bay leaves, washed the buckets, and rebaited the traps with fresh bay leaves attached to new floats and added fresh water. We initially placed the buckets in the plots on April 4 and 5. The water and bay leaves in the buckets were replaced on April 25 and 26. The second set of bay leaf baits and the buckets were removed from the field on May 16 and 17. We also set up a rain gauge in one plot at each location, which was checked after each three-week baiting period.

Leaf baits removed from the buckets were incubated in manila envelopes for 5 days. We then plated tissue pieces from symptomatic leaves on PARP media at David Rizzo's lab at UC Davis. Personnel from the Rizzo lab assisted with the plating of first batch of leaf samples.

Our 2007 monitoring of inoculum production in study plots from the beginning of April through mid-May confirmed that weather conditions in spring 2007 were unfavorable for *P. ramorum* inoculum production. We did not detect any *P. ramorum* on bay leaf baits in any of the tanoak plots. Rainfall measured in plots was low during this period. Rainfall amounts in the first 3 weeks of April were about 2.5-5.8 cm in the plots, but in the following three week period, only 0.13-0.4 cm was recorded.

Results from the spring 2007 inoculum monitoring are consistent with those of other researchers sampling in northern California during this period. The overall lack of *P. ramorum* inoculum production in the plots did not allow us to determine whether inoculum production was affected by the Agri-fos® treatment. However, it does suggest very few or no new infections in the plots would have been likely to occur in spring 2007. Hence, trees that have shown trunk symptoms for the first time in 2007 were almost certainly infected in previous years. Monitoring by researchers in Dr. David Rizzo's lab has indicated that the spring of 2005 and especially 2006 were favorable for *P. ramorum* inoculum production.

Efficacy. Monitoring disease development on tanoaks within the study plots is our main method for determining whether the Agri-fos® treatment is effective. We assessed the disease status of each tanoak stem in the plots prior to the start of the study and are periodically reassessing the stems to detect evidence of disease. The plots that were established in the winter of 2005/2006 have now been observed for 1.5 years since the start of the experiment. Likely symptoms of *P. ramorum* canker were noted in one of these two locations (SF) within the first 6 months of the study, and trees killed by *P. ramorum* were present in some of the plots by 1.5 years after the start of the study. At the other location (BL), likely *P. ramorum* canker symptoms were not noted until 1.5 years after the start of the study.

To date, the numbers of symptomatic trees in treated and control plots are still too low to draw any solid conclusions about Agri-fos® efficacy. Tree mortality due to *P. ramorum* has been observed in one Agri-fos® treated plot (Table 1-4). Because symptoms were seen in some of these trees within the first 6 month of the study, it is possible that many, if not most, of these trees had existing but cryptic cankers at the start of the study. Given the negligible inoculum production in the plots in spring 2007, it is likely that any disease symptoms first seen in 2007 result from pre-existing infections dating to 2006 or earlier. However, it is not possible to differentiate between trees that had cryptic infections in 2005 (before the first Agri-fos® application in the SF and BL plots) and trees that were initially infected in the winter and spring in early 2006 (after the first application in the SF and BL plots).

In addition to tree mortality, additional trees with *P. ramorum* symptoms are present in both phosphite-treated and control plots at both the SF and BL locations. At SF, the highest incidence of disease symptoms (about 20% of stems) is currently in the phosphite-treated plot. Symptom incidence in thinned (8%) and nonthinned (14%) control plots is currently lower, but not significantly different from the symptom incidence in the phosphite-treated plot. At BL, only a few symptomatic stems have been seen as of May 2007; none are in the phosphite-treated plot.

Table 1-4. Mortality of tanoak stems attributed to *P. ramorum* observed 18 months after initial treatments. Plots were initially treated in December 2005.

Plot	total number of stems	Number of dead stems attributed to *P. ramorum*	Percent dead stems attributed to *P. ramorum*
BL3 Agrifos+thin	58	0	0%
BL4 thinned control	59	0	0%
BL5 nonthinned control	58	1	1.72%
SF1 Agrifos+thin	63	3	4.76%
SF2 thinned control	61	0	0%
SF6 nonthinned control	72	4	5.56%

Various researchers have noted that phosphite is most likely to be effective when applied as a protectant to uninfected plants; it is generally much less successful at limiting established infections. This may explain at least some of the disease that has shown up in Agri-fos® treated plots.

Another interesting point is that most of the symptomatic and dead trees in the Agri-fos® treated plots are large-diameter trees. At this point, tree diameter and plot thinning, but not Agri-fos® application, are significantly related to the risk of disease in logistic regression models. This raises the question as to whether the concentration of phosphite in trees treated via stem spray application is high enough in the large-diameter trees. Large-diameter trees receive proportionately less phosphite per unit stem volume than do small diameter trees even though we use a spray volume that has been calculated to reduce the magnitude of this disparity. It is not possible to completely correct for this effect in large-diameter trees because only a limited amount of spray volume can be adsorbed onto the bark surface. As we gather additional data on disease development in these plots, we should be able to discern whether the efficacy of the treatment is affected by stem diameter, which could have significant implications for the use of phosphite to control SOD.

Objective 2. Protection of oaks using selective removal of California bay.

This study is based on matched pairs of SOD-susceptible oaks (coast live or California black oak). The trees within the pairs are matched to the degree possible for known factors that influence disease risk, especially the amount of bay in the immediate vicinity of the trunk. One tree of each pair is designated as the control and is not altered in any way. For the other (treated) tree, we are removing bay from the zone nearest to the trunk. The minimum clearance we have tried to achieve is 2.5 m of horizontal distance between bay foliage and the oak trunk. Where it can be achieved without excessive effort, the clearance is increased up to about 5 m, especially in the direction of the prevailing storm winds (generally south and west of the tree). This generally includes the removal of entire small-diameter bay stems close to the oak and/or bay branches from bays located farther from the oak.

Locations used in this study are in Sonoma and Napa Counties in areas where *P. ramorum* is present and causing symptoms on bay and usually at least some oaks. The locations included in the study to date are summarized in Table 2-1.

Table 2-1. Number of bay removal study pairs at study locations.

Location	Coast live oak pairs	California black oak pairs	Date of bay removal
Wall Rd.	7		Jan 2007
Annadel SP	7	6	Feb 2007
JT/GVR	11		March 2007
Jacobs Ranch	5	4	May 2007
SA	1	8	November 2007
Total pairs	31	18	

Because localized bay removal is primarily a preventive treatment, oaks selected for the study were generally free of obvious stem cankers. However, we have included eight pairs of trees with small cankers in the study to assess whether disease progress could be slowed by reducing the amount of additional inoculum that lands on already-infected trees.

Bay removal treatments were initiated in spring 2007. To date, 31 coast live oak pairs and 18 California black oak pairs have been established, each pair consisting of matched control and treated (bay removal) trees. All pre- and post- pruning data on tree health and bay cover has been collected for these pruned trees. With additional funding provided by Amendment 1, we scouted an additional location for study pairs (SA). We collected baseline data in late summer 2007 and and removed bay around designated trees in November 2007.

Study trees will need to be observed for a number of years to determine whether treated oaks are less likely to develop SOD than untreated trees. We will also be evaluating the amount of regrowth that occurs from cut bay stumps, which are not being treated with herbicides to prevent resprouting.

To minimize the costs associated with felling/pruning and the handling of downed material, we have generally selected oaks that require relatively little bay removal to make a large change in disease risk. Ideal oaks for treatment are those with only one to a few small diameter understory bays near the trunk. These situations commonly occur where bay is not the dominant tree in the stand. To date, the largest diameter bay stem we have removed was about 9 inches (23 cm) DBH. However, even small diameter bays are often quite tall. In dense stands, felled bay stems commonly hang up in the canopies of other trees and can be time consuming to drop.

Where downed material is being left on site (lop and scatter), we have been leaving cut bay foliage at least 1-2 m away from the trunks of susceptible oaks. This is based on the concept that splash dispersal of most *P. ramorum* inoculum from bay foliage near the ground is generally likely to be limited to about 1 m or less. Depending on weather conditions and exposure to sunlight, cut bay foliage can dry out within a few days to weeks. In heavily shaded stands during cool, wet conditions, bay foliage can remain green (and potentially a source of *P. ramorum* inoculum) for at least a month. Hence, at least during the rainy season, we believe it is prudent to keep cut bay foliage away from susceptible oak trunks until it is thoroughly dry.

Inoculum monitoring in plots. During the spring of 2007, we monitored inoculum dispersal near the trunks of trees in 3 pairs each at Annadel State Park and the Wall Rd. locations using buckets containing bay leaf baits as described for the tanoaks above.

As noted for the tanoak plots above, we did not detect any *P. ramorum* on bay leaf baits from any of the sampling buckets around control or treated trees. As with the tanoak plots, rainfall measured in plots was low during the monitoring period (beginning of April through mid May). Rainfall amounts in the first 3 weeks of April were 1.6 (4.2 cm) and 2.4 inches (6.1 cm) beneath tree canopy at the two locations. In the following three week period, we recorded 0.3 and 0.5 inch (0.7 cm and 1.3 cm) of precipitation throughfall through the canopy.

Efficacy. Based on spore monitoring data, it is likely that very few, if any, new stem cankers were initiated in spring 2007 on study trees. If rainfall conditions are favorable for *P. ramorum* sporulation in spring 2008, the soonest that we would expect to be able to begin detecting new infections would be late 2008. Since the latent period before symptom expression may be at least a year on longer, based on our observations in long-term plots, we will need to assess disease in these trees for several years in order to determine whether the bay removal treatment is successful.

Bay regrowth. Although bay stumps could be treated with herbicides to inhibit subsequent sprouting, the cut stumps in this study have not been treated. We will therefore be able to assess how fast sprouts regrow and how often followup treatments would be needed to maintain the desired clearance between bay foliage and the oak trunk. After a lag of several months, we did observe sprouts developing from cut stumps by mid-April. Some of these new shoots were browsed by deer. It remains to be seen how well deer browsing alone will suppress bay sprout regrowth.

Presentations:

On April 24, Ted Swiecki discussed the study and presented information on Agri-fos® treatment at a SOD training session for arborists, homeowners, and agency employees held at Pt. Reyes National Seashore.

On November 15, 2007 Ted Swiecki discussed sudden oak death epidemiology and control at a SOD training session for homeowners in Green Valley, Solano County.