

Novel Approaches to SOD Management in California Wildlands: A Case Study of “Eradication” and Collaboration in Redwood Valley¹

Y. Valachovic,² L. Quinn-Davidson,² C. Lee,² E. Goldsworthy,² and P. Cannon³

Abstract

In California, sudden oak death (SOD) treatment efforts have been localized, often targeting specific trees or properties. The widespread nature of SOD establishment and spread in coastal mountains of California has mostly precluded use of broader eradication strategies, which are more applicable in isolated infestations like those in Oregon. However, the 2010 detection of a new infestation in Redwood Valley, California—more than 80 km from the nearest known infestation, and the northernmost known occurrence in the state—presented an opportunity for the first attempt at containment and potential “eradication” in California. The infestation was isolated to a relatively small geographic area and was of high priority, effectively located at the gateway to Redwood National Park, Yurok and Hoopa tribal lands, Bureau of Land Management (BLM) and US Department of Agriculture Forest Service (USDA FS) lands, and the dense tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh) forests of the Klamath watershed.

Given the nature of the Redwood Valley infestation and its proximity to important ecological and cultural landscapes, spread of the disease from this area is highly undesirable. However, the context for the management in this area was complex, requiring careful collaboration from the beginning. The pathogen was initially detected through stream sampling near Orick in May 2010, many miles downstream from Redwood Valley and near the mouth of the 80,937 ha (200,000 ac) Redwood Creek watershed. Only through extensive sampling and the targeted engagement of large landowners throughout the watershed was the source of the infestation narrowed to Redwood Valley. Even then, the infestation spanned a number of private properties, including small residential landholdings and large private timberlands, and necessitated the cooperation and commitment of diverse stakeholders. Likewise, the project required a prompt, creative funding strategy and ultimately involved the support of the USDA FS, the Natural Resources Conservation Service (NRCS), California Department of Forestry and Fire Protection (CAL FIRE), the University of California, local contractors, and private landowners. The multi-tiered collaboration required by this project is unique for SOD management efforts in California, where treatments have previously been limited in size and scope.

As this disease advances, we must develop new management approaches while gleaning fresh insight from old strategies. The Redwood Valley project, which blends a unique social and geographic context with a treatment strategy not yet used in California, provides new tools and inspiration for disease response. It also highlights the increasing need for a comprehensive strategic response plan, one that could moderate the coordinating and funding challenges that were encountered in the Redwood Valley example and are likely to emerge in future cases.

Key words: *Phytophthora ramorum*, sudden oak death, eradication, management, collaboration

Introduction

In California, sudden oak death (SOD) treatment efforts have been localized, often targeting specific trees or properties. The widespread nature of *Phytophthora ramorum* establishment and spread in

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² University of California Cooperative Extension, 5630 South Broadway, Eureka, CA 95503.

³ USDA Forest Service, 1323 Club Drive, Vallejo, CA 94592.

Corresponding author: yvala@ucanr.edu.

California has mostly precluded use of broader control strategies, which are more applicable in isolated infestations like those in Oregon. However, in the last decade, the pathogen has spread north to previously uninfested Humboldt County, and patchy, discontinuous infestations there have presented new opportunities for treatment, with less than one percent of the at-risk habitat infested to date.

This paper will focus on recent treatment efforts in Redwood Valley (northern Humboldt County), which were based on early experimental efforts in southern Humboldt County (Valachovic et al., Suppression of *P. ramorum* infestations through silvicultural treatment in California's north coast, this proceedings) and on treatment projects in Oregon (Goheen et al. 2010). The Redwood Valley management efforts will require sustained and continued attention, but its development and its outcomes are notable in a number of ways. First, the discovery of the Redwood Valley infestation is testament to the efficacy of stream monitoring efforts taking place in California's north coast and beyond. Second, the project is an example of the careful collaboration necessary for rapid disease response, especially in California's complex social and ecological landscape. Third, the Redwood Valley project has made enduring contributions to the regulatory and funding structure around SOD; the newness of the disease and the consequent lack of institutional infrastructure for SOD treatment in Redwood Valley necessitated the development of new, SOD-specific regulatory categories and funding options, which are now available for other similar treatment efforts. In these ways, the Redwood Valley project has not only advanced the collective understanding of what it takes to treat SOD, but it has also laid important foundations for future collaboration and action in California's wildlands.

Finding *Phytophthora ramorum* in Redwood Valley

In the California north coast region, stream monitoring is the primary method used for early detection of *P. ramorum*, the pathogen that causes SOD. Mesh bags containing fresh, disease free rhododendron leaves are placed at strategic locations in streams and rivers—effectively baiting the pathogen—and follow-up laboratory tests determine whether or not leaves became infected with *P. ramorum* while they were in the stream. If samples test positive for the pathogen, further efforts are needed to determine the terrestrial source of the inoculum present in that watercourse. A broad network of north coast streams has been monitored since the early 2000s, and though these monitoring efforts do not cover all of the watersheds in the region—they are limited by access issues and available resources—they remain one of the most critical tools for SOD detection in the area.

In May 2010, a sample collected near the mouth of Redwood Creek (near Orick) tested positive for *P. ramorum* for the first time in its 7-year monitoring history. This positive sample was significant not only because the site had previously been free of the pathogen, but also because it was the first detection in northern Humboldt County—more than 80 km north of the nearest known infestation in California and at the gateway to Redwood National Park, Yurok and Hoopa tribal lands, Bureau of Land Management (BLM) and U.S. Department of Agriculture Forest Service (USDA FS) lands, and the dense tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh) forests of the Klamath watershed (fig. 1).

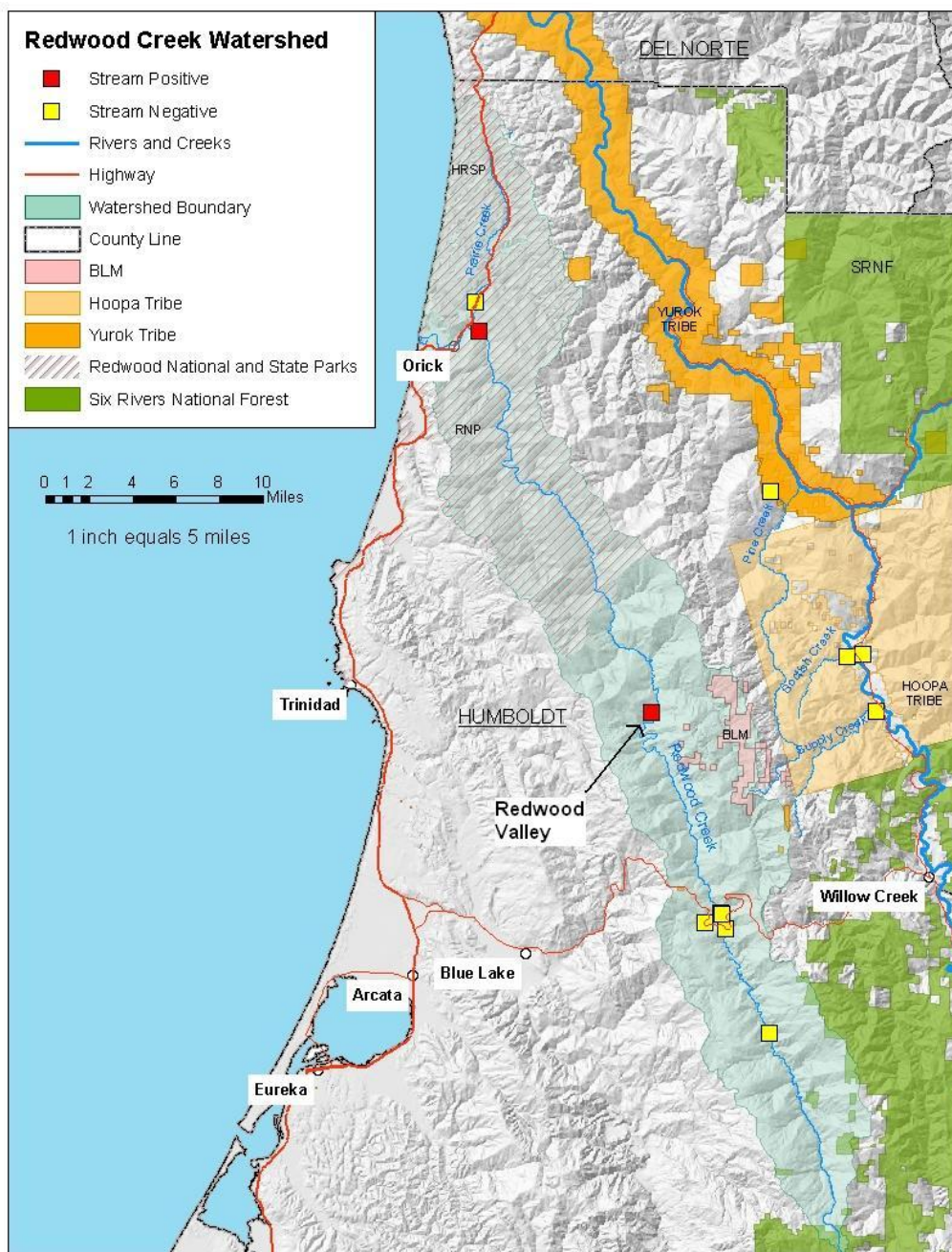


Figure 1—The Redwood Creek watershed, with location of stream positives at Orick and in Redwood Valley. Map also shows adjacent public and tribal lands. The Redwood Valley infestation was more than 80 km north of the nearest known infestation in California.

The positive sample in Redwood Creek was only the beginning of a much larger effort; the next task was to identify the source of the pathogen, which was somewhere in the 80,937 ha (200,000 ac) watershed. University of California Cooperative Extension (UCCE) staff, who facilitate much of the *P. ramorum* monitoring in the north coast region and had collaborated with UC Davis and Redwood National Park in the monitoring of Redwood Creek, took a lead role in follow-up efforts associated with the Redwood Creek sample. They held a meeting with the major landowners in the watershed to inform them of the positive test result and gain access for further surveying. They also expanded the local stream monitoring network to include as many Redwood Creek tributaries as possible, hoping to

narrow the infestation to a more manageable sub-watershed. In spite of these efforts, the pinpointing of the infestation in Redwood Valley—a residential area in the middle of the largely unpopulated watershed—was somewhat coincidental. In July 2010, a UCCE staff person who was walking from the road to the creek to pick up a stream monitoring bag recognized the symptoms in the immediate area. Using aerial reconnaissance by USDA FS flight teams and substantial ground surveys, the team confirmed that the infestation was small, limited geographically to Redwood Valley.

Treatment in Redwood Valley

Deciding to Treat

After years of working on SOD in the north coast region, UCCE was well positioned to advance discussion and action in Redwood Valley. Long before the discovery of the Redwood Valley infestation, UCCE was working on SOD-related outreach and education across the county and had formed a coordination group to help guide efforts. They were also engaged with the larger disease management community in California, with strong ties to the California Oak Mortality Task Force (COMTF), scientists within the University of California (UC) and Oregon State University, scientists and pathologists with the USDA FS, California Department of Forestry and Fire Protection (CAL FIRE), and other federal and state agencies. In approaching the Redwood Valley infestation, UCCE brought together these partners and found strong support from scientists, funders, and affected landowners for management.

Given the sensitive location of the Redwood Valley infestation, there was widespread interest in treatment from the beginning. Redwood Valley is close to many important public lands, including Redwood National Park and BLM areas, and it is also adjacent to tribal and private forest lands. The forests surrounding Redwood Valley—especially to the east—are thick with tanoak, and the potential for SOD-related mortality is very high. Redwood Valley is also one of the few areas in the watershed that is accessible for crews and equipment; if the pathogen were to spread down river or into the upper watershed, there would be no practical way to treat it. Given these shared concerns, public, private, and tribal land managers in the area were supportive of swift, comprehensive treatment.

Project Collaborators

Many agencies and organizations were involved in early planning efforts. Staff from UCCE brought forward their experience with various *P. ramorum* treatment approaches in southern Humboldt County, and funding from the American Recovery and Reinvestment Act (ARRA) allowed them to devote consistent time and energy to the project. Researchers from UC Davis's Rizzo lab were instrumental in this early phase of the project; they were primary collaborators on the stream monitoring efforts that first revealed the new infestation, and they continued to offer critical scientific input, fieldwork, and lab work as the project moved forward. The Garbelotto lab at UC Berkeley also supported the project, conducting genetic testing of *P. ramorum* in Redwood Valley and offering insight on the origin of the pathogen, which appeared more related to the infestations in southern Humboldt County than to the nursery positives in the nearby McKinleyville area. Other early collaborators included CAL FIRE, the Vegetation Management staff at Redwood National Park, industrial and non-industrial private landowners in Redwood Valley, scientists and forest pathologists from the USDA FS Forest Health Protection Program and the Pacific Southwest Research Station, staff from the BLM, and more. As the project became better developed, other important collaborators stepped in to provide funding and labor, including the Natural Resources Conservation Service (NRCS) and CAL FIRE.

Treatment Methods

The treatment in Redwood Valley was based on the experimental treatments that were implemented in southern Humboldt County (Valachovic et al. 2010; Valachovic et al., Suppression of *Phytophthora ramorum* infestations through silvicultural treatment in California's north coast, this proceedings) and on the experiences from the southern Oregon management efforts (Goheen et al. 2010). The prescription included the removal of all tanoak and California bay laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.) within 100 m of infected trees (fig. 2). The cut material was either piled and burned on site or securely trucked off site and donated to a local power company, or, when neither of those options was feasible, the material was lopped and scattered on site. In two situations, landowners had special (often large diameter) trees that they did not want removed, so those trees



Figure 2—Before and after treatment in Redwood Valley, spring 2012. (Photos by L. Quinn-Davidson)

were limbed to reduce the total live crown of potentially infected foliage, decrease tree-to-tree connectivity, and increase airflow. One of the major landowners in the valley—a private timber company—took responsibility for treatment work on their land by using an herbicide to treat standing California bay laurel and tanoak trees within 100 m of infected trees. The UCCE team was responsible for surveying the extent of the infestation and providing crews with maps of infected trees.

Because tanoak and California bay laurel are both prolific basal sprouters, herbicides were used where possible for post-treatment stump control. Originally, imazapyr was the primary chemical used for both tree species; it worked well on tanoak stumps, but close observations of California bay laurel stumps indicated that imazapyr alone would be slower to control California bay laurel sprouts. Staff from UCCE found similar results on standing trees in earlier experiments in southern Humboldt County, but had not yet used imazapyr to control stumps. A combination of imazapyr and glyphosate, which they found effective for standing California bay laurel trees, should be a more effective treatment for California bay laurel stumps, and has been used in the second round of stump control in Redwood Valley.

Funding

The Redwood Valley project involved financial and other contributions from a number of collaborators. As mentioned previously, ARRA funding supported UCCE staff in coordinating the project. The USDA FS contributed funds for treatment and monitoring, and NRCS contributed funds for treatment through their Forest Stand Improvement program. Forester time for surveying and significant crew time for project implementation were contributed by CAL FIRE, and private landowners also donated labor and money to the project.

The cost per hectare of treatment in Redwood Valley varied greatly from property to property. Some of the treated areas were residential, requiring careful work by highly skilled contractors. In some cases, tree removal around houses was performed with a boom lift, and trees were removed piece by piece. In these areas, it was also very important for cut material to either be piled and burned or trucked off site. This residential work was complex and slow and was significantly more costly than the work performed in wildland settings. Wildland work was conducted primarily by CAL FIRE crews or private contractors, who moved relatively quickly and were able to lop and scatter much of the cut material on site.

Project Outcomes

Treatment

The first phase of treatment in Redwood Valley was completed in spring 2012 and covered approximately 150 ha on almost 20 different properties. Follow-up stump control work occurred in the late fall of 2012, and more treatment work may take place in the future, depending on the results of current project monitoring activities.

However, the outcomes of the Redwood Valley project extend beyond the physical boundaries of the treatment. The project necessitated the development of important new regulatory and funding structures for SOD treatment work in California, and those options are now in place to enable future efforts.

New “Component” for NRCS Forest Stand Improvement Program

The NRCS supports forest management actions on private lands through its Forest Stand Improvement (FSI) program, NRCS Practice Code 666. Typically, projects that are funded through the FSI Practice fulfill one or more of the “components” listed in the code, including prescribed burning, firebreaks, tree/shrub pruning, erosion control, and more. When NRCS stepped forward to support the efforts in Redwood Valley, they were lacking an adequate component for SOD treatment activities, which require sanitation and urban-interface considerations not common in typical FSI

activities. Staff from NRCS worked with UCCE and other project collaborators to develop a new FSI component for SOD treatment, which included strict, SOD-appropriate requirements for equipment sanitation and handling of infected plant material, and technical and legal requirements appropriate for tree removal work near homes. The per-acre value of the new SOD treatment component (i.e., the amount NRCS is willing to pay landowners per acre of treatment) was based on estimates given by arborists for work in Redwood Valley, and it was significantly higher than any existing component under the FSI Practice. This component is now established and available for use in future SOD treatment efforts. It could also be adapted for use in different NRCS programs or initiatives, if necessary. For example, the new component was developed specifically for the urban-interface setting in Redwood Valley, but NRCS may develop a lower cost alternative for similar work in wildland settings.

New Regulatory Language in California Forest Practice Rules

In January 2011, the California Board of Forestry approved a temporary emergency regulation for control of *P. ramorum* in California's privately owned forestlands. This emergency rule was drafted and adopted in response to the Redwood Valley infestation, which was one of first California infestations to include commercial timberlands and called attention to the need for regulatory options that enable and encourage swift silvicultural treatments in SOD-infested areas. In March 2012, the Board voted to permanently adopt the new rule, regulation 14 CCR § 1052.5, Emergency Notice for Outbreaks of Sudden Oak Death Disease.

The new regulation, which went permanently into effect in January 2013, allows use of an Emergency Notice to manage infected forestlands through harvest of infected trees. Using this permit, landowners may be able to offset some of the costs of treatment work through commercial utilization of diseased trees. Although landowners and foresters have the ability to take some of these actions without the new regulation (under existing rules), they are not allowed to commercially utilize any of the harvested materials without filing a Timber Harvest Plan, which is a much slower permit to prepare and receive approval for. Additionally, the new regulation allows harvesting and commercial utilization of infected or symptomatic trees near streams and wet areas, where most of the California bay laurel is found. This new regulatory language will increase the options available to affected landowners, offset some of the costs of treatment activities on private forestlands, and, most importantly, help control the spread of *P. ramorum* in California.

Lessons Learned

It's been 2 years since *P. ramorum* was discovered in Redwood Valley. In that time, a wide range of collaborators have worked together to secure funds and implement treatments in an effort to protect and conserve the vulnerable forests of California's north coast. Over 150 ha have been treated, and project partners have invented creative new funding and regulatory options to enable efficient, appropriate action. The scale of the treatment and the level of collaboration—both in funding and in implementation—is unprecedented for this type of work in California, and in these ways, the project has been a major success.

However, the project has also faced a number of challenges, from social to climatic to biological. In a residential area like Redwood Valley, it takes significant time and effort to garner landowner support and coordinate the legal agreements and access necessary to survey and treat the project area. In this case, most landowners were supportive of the project, but some landowners had special requests and two (of 22) opted not to participate at all; luckily, the non-participating landowners were geographically central to the project and their untreated properties were buffered by treatment, yet the pockets of infested forest remain a threat to the integrity of the project.

Even more concerning has been the weather in recent years. The last two springs have been some of the wettest on record, and late, warm rains have supported rapid spread of the pathogen. The project boundary expanded several times during the treatment period due to the discovery of newly

infested trees, and post-treatment monitoring has recently revealing new pathogen detection outside of the treatment boundary. These weather concerns are compounded by the dearth of information on the lag time between infection and symptoms; treatment activities are based on surveys, but surveys rely on disease symptoms, and it is unclear what size treatment buffer will be sufficient to capture trees that are infected but not yet showing symptoms.

The challenges to treatment in Redwood Valley highlight important considerations for future efforts, both in the valley and beyond. For one, it appears that the 100 m buffer around infected trees is insufficient to contain spread of the pathogen, especially in wet years. This finding is corroborated by the treatment efforts in Oregon, which have employed a 100 m buffer (Goheen et al. 2010), but have recently scaled up to use a 300 m buffer where feasible following observations of annual distances between diseased trees (Hansen 2008). Second, landscape-scale treatment efforts for *P. ramorum* require monitoring that is consistent, frequent, and conducted at a scale that matches the scale of pathogen invasion, allowing for detection of the cryptic spread beyond the borders of infestation. This may require skilled monitoring teams dedicated solely to following up on sudden oak death treatment efforts, something that has been absent on treated private property in California because of funding constraints--although Redwood National Park hired a team of seasonal technicians to monitor the lower reaches of Redwood Creek (downstream of the project) and conduct comprehensive surveys throughout the park. Third, early and consistent outreach to area landowners is essential to engage them in educational efforts and enlist their assistance in monitoring; this is especially important for landowners at the periphery of the treatment area. Fourth, using only a grant-funded approach to disease management, especially when many view the disease as an “emergency,” will always have limitations in being able to rapidly deploy crews, allow for release time for staff to work on the disease and find sufficient funds to complete the work.

Conclusions

The Redwood Valley project is a pioneering effort in California; it is the first large-scale *P. ramorum* treatment project in the state, and it has involved an impressively diverse array of agencies, organizations, and landowners. However, the collaborators in the Redwood Valley project have faced difficult questions, and they have had to weigh the risks of managing the disease against the risks of not managing. This remains an ongoing challenge, especially in the face of continued pathogen spread in the area, but the project has engendered a strong partnership, one that will likely serve as a model for disease management in the future.

Beyond the social realm, the Redwood Valley project is also providing practical tools to encourage and inform future efforts. The project has already resulted in regulatory and funding options for *P. ramorum* treatment in California, giving landowners new incentives and opportunities for controlling the spread of the pathogen. And now, through further monitoring and critical consideration of the approach and techniques employed in Redwood Valley, the project will continue to contribute to the collective understanding of what it takes to manage and contain the pathogen. The insights gleaned from this project, in concert with the institutional changes that it inspired, will set a strong foundation for future collaboration and action within California.

Literature Cited

- Goheen, E.M.; Kanaskie, A.; Hansen, E.; Sutton, W.; Reeser, P.; Osterbauer, N. 2010. Eradication effectiveness monitoring in Oregon tanoak forests. In: Frankel, S.J.; Kliejunas, J.T.; Palmieri, K.M., tech. coords. Proceedings of the sudden oak death fourth science symposium, Gen. Tech. Rep. PSW-GTR-229. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 233–235.
- Hansen, E.M. 2008. Alien forest pathogens: Phytophthora species are changing world forests. Boreal Environment Research. 13: 33–41.

Valachovic, Y.; Lee, C.; Marshall, J.; and Scanlon, H. 2010. Forest treatment strategies for *Phytophthora ramorum*. In: Frankel, S.J.; Kliejunas, J.T.; Palmieri, K.M., tech. coords. Proceedings of the sudden oak death fourth science symposium, Gen. Tech. Rep. PSW-GTR-229. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 239–248.