Ongoing Adaptive Management Efforts for Sudden Oak Death at Lacks Creek

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The sudden oak death (SOD, *Phytophthora ramorum*) infestation in the Redwood Valley area of north-central Humboldt County has been, and continues to be, the focus of the most intensive SOD management effort in California. This area lies about 14-16 air miles inland from the coast, east of the town of Trinidad. The original infestation in Redwood Valley, thought to be the result of an introduction of infected ornamental plants, was discovered in 2010 and at the time was geographically isolated from any other infestations. An initial SOD suppression effort, spearheaded by University of California Cooperative Extension, Humboldt County, (UCCE) included over 400 acres of tanoak and California bay laurel removal centered on the infested zone. However, in 2012, another infested location was found in the Bureau of Land Management (BLM) Lacks Creek Management Area, situated over a mile east of the treatment area— likely initiated from a single longer distance dispersal event from Redwood Valley. This satellite infestation was coupled with continued development of SOD adjacent to the original treatment—particularly to the east—likely from individuals that already had cryptic infections at the time of treatment.

Adaptation of the management strategy was thus prompted, toward the use of silvicultural treatments at the leading edge of the eastern side of the infestation and beyond it, to prepare against the imminent arrival of the pathogen by creating conditions in which *P. ramorum* may be less likely to establish and/or move rapidly. Instead of removing all of the tanoak (Notholithocarpus densiflorus) and California bay laurel (Umbellularia *californica*) within the newly detectable infestations and in a buffer around them, part of the new strategy was not to treat within an infested zone if topography and vegetation would make the treatment extremely expensive, potentially unsafe for workers, and/or have adverse geologic effects. Rather, infestations in locations where treatment was more feasible were treated with fairly aggressive, but not complete, host removal (by cutting) in areas where disease incidence was heaviest. This included an area on private land directly adjacent to the BLM tract. Ahead of the leading edge of the known infested areas, most or all bay laurel stems were cut and tanoak heavily thinned in prioritized areas. Annual stream monitoring and ground surveys were utilized by UCCE to track disease movement and inform treatment prioritization by the BLM and UCCE. Treatments have been conducted each year since the initial Redwood Valley treatment in 2011/2012 through 2017 (see map, figs.1a and 1b), mostly funded by the US Forest Service, State and Private Forestry. The map shows locations of vegetation samples that were positive for *P. ramorum* prior to treatment. Research plots (installed by UCCE and UC Davis, Rizzo Lab) in untreated areas and post-treatment will be re-measured and assessed for disease this summer (2019). Transect surveys in summer 2018 detected some new disease development in untreated areas, but none in areas that had been treated prior to having any known infestation.

Treatment is currently ongoing. Mastication is being used to treat where slopes are gentle enough, as the cost is slightly lower than hand-thinning, piling, and pile-burning. Hand-thinning (*i.e.*, by chainsaw) is being used in steeper terrain. Treatments target bay laurel first and then move to tanoak, with partial retention of these hosts based partly on the density of other tree species. To date, the BLM has contracted about 300 acres, and UCCE about 210 acres, of treatment in the Lacks Creek Management Area, to be completed June 2019. The top priority treatment areas in 2017 and 2018 were locations where new, small infestations were found over a mile east of those known the previous year. In an area that UCCE had treated in 2017 bordering a perennial creek, a relatively high density of bay laurel (Figs. 2, 3 & 4) was cut in the infested area to reduce pathogen spread. Bigleaf maple (*Acer macrophyllum*) and red alder (*Alnus rubra*) were propagated from material collected from the treatment area and recently planted to re-vegetate this area. A few then-healthy tanoak that were left in this treatment block in 2017 began to show disease symptoms in 2019 and are currently being removed. The BLM has secured Cal Fire Forest Health Program funding to treat at least 1,500 additional acres in 2019 through 2021, starting adjacent to the area currently being treated under a UCCE-led (also Cal Fire-funded) project. The planned BLM treatments are designed to make the landscape more resilient to SOD and fire, as well as to maintain road access/egress and promote late-seral forest characteristics. It is hoped that these treatments will

also slow the movement of SOD toward the Hoopa reservation (3 miles to the east), allowing the Hoopa and other nearby tribes, to whom tanoak is an important resource, more time to complete additional treatments to make their forests more resilient to SOD and fire.



Figures 1a and 1b. **1a.** Map showing distribution of vegetation samples that were positive for *P. ramorum* prior to treatment and the treated areas near Lacks Creek. **1b.** Maps showing general site location in California and Humboldt County.



Figure 2. An area where a SOD infestation was found in 2017: pre-treatment (left), and post-mastication thinning treatment (right). Prior to treatment, the area had an abundance of California bay laurel.



Figure 3. Hand removal of bay laurel in spring 2019 since a masticator could not reach the trees in fall 2018. The treatment area is in the same infested block as shown in Fig. 2.



Figure 4. Post-mastication forest with mostly Douglas-fir (*Pseudotsuga menziesii*) and Oregon ash (*Fraxinus latifolia*) trees remaining. Pre-treatment, this forest had an abundance of CA bay laurel and was infested with *P. ramorum*.



Figures 5a and 5b. David McLean, UCCE, hauling seedlings (left) and planting a bigleaf maple seedling (right) where California bay laurels were cut in a SOD infestation zone.



Figures 6a and 6b. Pre-treatment (left) and post-mastication thinning (right); yellow triangle shows the same tree seen from downhill (left) and uphill (right). A preemptive treatment was conducted in this high-density tanoak forest.



Figure 7. Post-treatment forest after mastication of understory tanoak and Douglas-fir, about 200 yards from nearest known SOD-infected trees. Remaining forest is dominated by Douglas-fir with infrequent Pacific madrone (*Arbutus menziesii*) and tanoak.



Figure 8. Large excavator-mounted masticator drives into thick bed of masticated wood for cleaning after finishing work in infested area (left). Power-washing the excavator (right).