2020 Cooperative California Stream Monitoring, Outreach and Diagnostic services for *Phytophthora ramorum*

Conducted by UC Davis, Plant Pathology, David Rizzo Laboratory, Evan Lozano, Cole Engert and cooperators

Results. In Humboldt Co., Upper Yager Creek, first detected positive in 2019, tested positive for *P. ramorum* again in two of the first three sampling periods in 2020. Chadd Creek was positive again in 2020; it was first detected positive in 2018 but was not sampled in 2019. Stanley Creek, monitored for the first time in 2020 by the Mattole Restoration Council, was positive during the first of three bait deployments. San Carpoforo Creek (San Luis Obispo Co.) and Salmon Creek (Monterey Co.), both were positive in 2020. Detailed results by county are provided below.

Methods: In previous years, selected California waterways were baited for *P. ramorum* five times between February and June. Due to COVID-19 precautions, sites for the 2020 *P. ramorum* stream monitoring survey were only sampled once, with the exception of those processed by UC Cooperative Extension in Humboldt Co. (UCCE), which were sampled following a modified schedule, for a total of three sampling periods.

In 2020, 44 streams were monitored across north and central coastal California, by collaborators from multiple institutions. This is a slight decrease in sampling sites from 2019; streams in the Yurok tribal lands were not monitored in 2020 due to COVID-19 precautions. Previously monitored sites retained in 2020 were selected to maximize detection of *P. ramorum* spread into high-risk and high-value forests, particularly at the boundaries of the pathogen's known range in northern Humboldt Co. and throughout Del Norte Co.

Collaborators at UCCE processed samples from Humboldt Redwood Company, Karuk Department of Natural Resources, Del Norte Agriculture Department, Mattole Restoration Council, Cal Fire and UC Cooperative Extension.

Table 1. 2020 Stream Monitoring Sites by California County.

County	Number of sites
Del Norte	11
Humboldt	28
Monterey	1
San Luis Obispo	4
Total	44

Del Norte County. Eleven sites in Del Norte Co. were tested, the same number as in 2019. In 2012, PCR-based diagnostic tests indicated possible *P. ramorum* presence in a single sample collected from the main stem of the Smith River. Since 2013, the Smith River watershed has been intensively sampled. Previously, *P. ramorum* was isolated once in May 2018 from the main stem of the Smith River, but was negative in 2019 and during the first 3 deployments of 2020. Initial results from the first half of the 2020 season show that there are no new positives in Del Norte Co. (Figure 1).

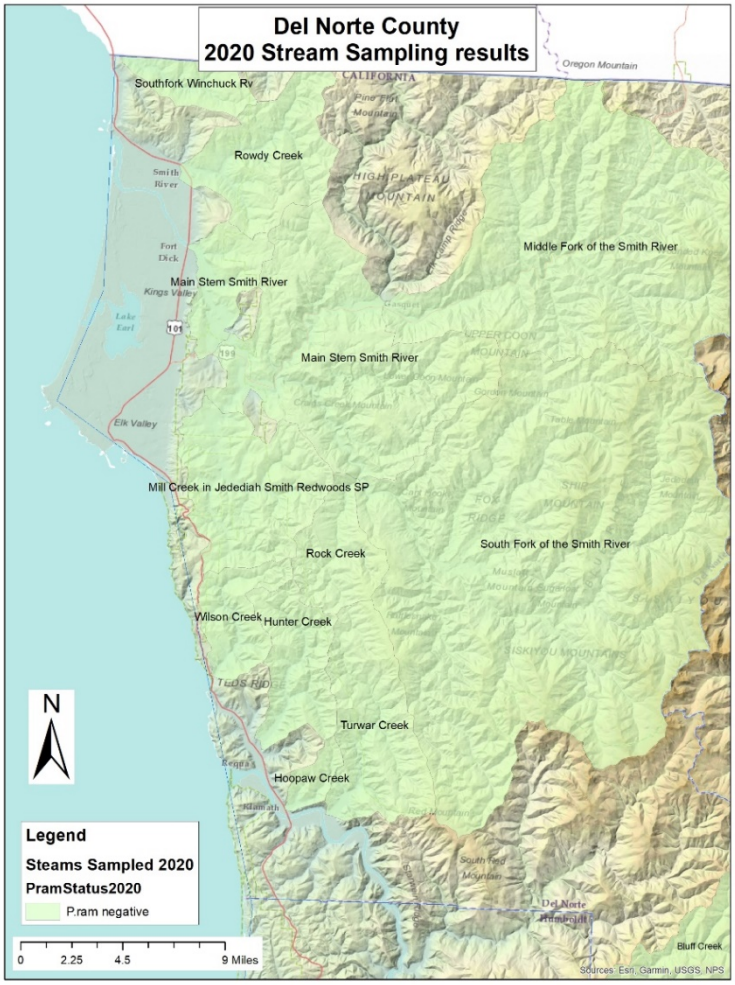

Figure 1. Streams sampled in Del Norte Co. for *P. ramorum* in 2020. The pathogen was not detected in any sampled streams.

Humboldt Co. Due to COVID-19 precautions, the number of stream monitoring sites in Humboldt Co. decreased to 28 in 2020, from 38 in 2019. All samples were initially processed by UC Cooperative Extension (UCCE) except samples from Hoopa tribal lands which were processed at UC Davis (Figure 2, left).

Northern Humboldt. Most of the sites monitored in this area are managed by Hoopa Tribal Forestry (6 sites), the Karuk Tribe (6 sites), and Yurok Tribal Forestry (10 sites). Sites within Yurok Tribal Forestry jurisdiction were not sampled in 2020. Thus far in 2020, *P. ramorum* has not been detected from any streams east or north of the Redwood Creek watershed. Sampling has remained focused here due to unknown inoculum source from the 2015 detection of *P. ramorum* well upstream of the known Redwood Valley Infestation.

Central & Southern Humboldt. In central and southern Humboldt Co. streams continued to be monitored within the Mad, Van Duzen, Eel River, and Mattole River watersheds and were sampled by UCCE (6 sites) in collaboration with Mattole Restoration Council (6 sites). Two previously positive (control) waterways, Mill and Widow White Creeks, were sampled and processed by UCCE and both were negative for *P. ramorum* in the first 3 deployments of 2020 (Figure 3 below & Figure 4 on next page).

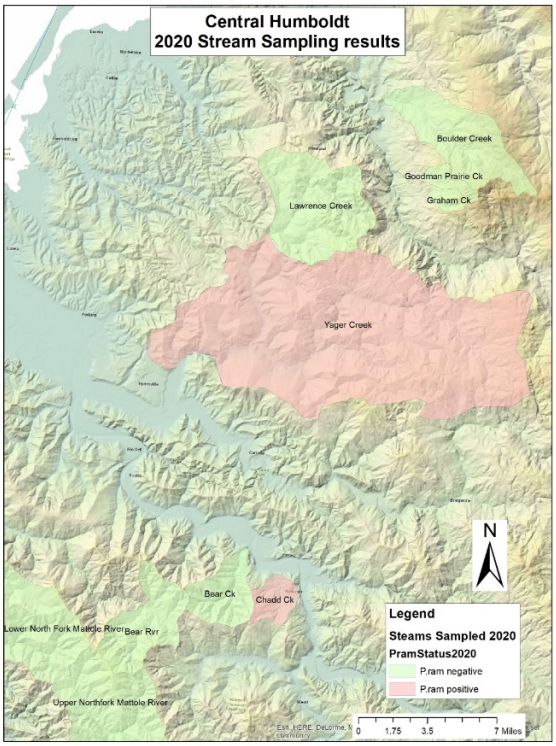

Figure 3. Central Humboldt stream sampling results.

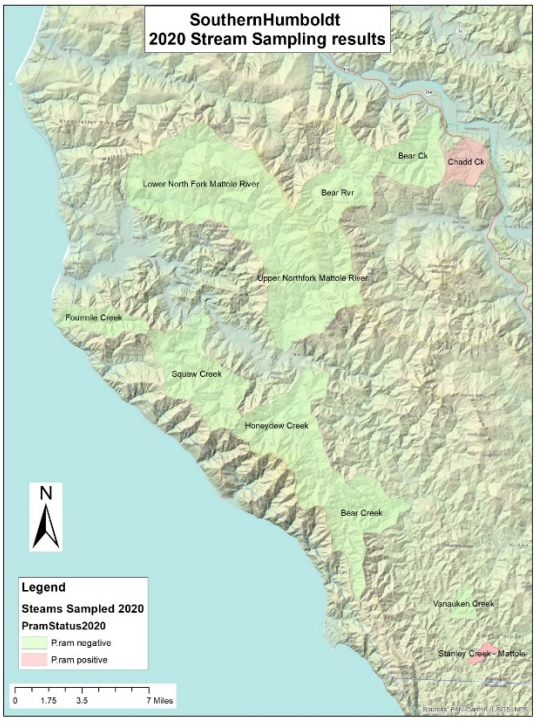

Figure 4. Southern Humboldt 2020 streams sampled.

Monterey & San Luis Obispo Cos. San Carpoforo Creek was previously found positive initially using PCR-based testing in 2012, then isolated in 2017 and 2019, and tested positive again in 2020. This sampling site is located at the northern border of San Luis Obispo Co.; The San Carpoforo Creek watershed is located in both San Luis Obispo and Monterey Cos. Salmon Creek, a watershed directly northwest of San Carpoforo Creek, was positive in 2018, 2019, and again in 2020. Three additional sites were monitored within San Luis Obispo Co., Santa Rita, Santa Rosa, and San Simeon Creeks. Santa Rita Creek and Santa Rosa Creek were found to be positive for the first time in 2019. Both Santa Rosa and Santa Rita Creeks were negative for the first 3 deployments of 2020. Results are pending deployment of Monterey and San Luis Obispo sites that occurred later in the year.

2020 Stream Monitoring Collaborators: *Del Norte and Humboldt Cos.:* Hoopa Valley Tribal Forestry (Kimberly Davis); Mattole Restoration Council (Lisa Hintz); UC Cooperative Extension Humboldt/ Del Norte (Yana Valachovic, David Mclean, Brendan Twieg); Yurok Tribal Forestry (Kim Mamaradlo, Talbert Alvarado). *Monterey and San Luis Obispo Counties*: Cal Fire (Kim Corella, Kelsey Glastetter).

DIAGNOSTICS/MANAGEMENT/FIELD MONITORING (Kerri Frangioso, Evan Lozano, Cole Engert)

UC Davis Rizzo lab personnel continue to provide diagnostic support to various state and federal agencies, including: UC Cooperative Extension in Humboldt - Del Norte Counties, Cal Fire, Redwood National and State Parks, California State Parks, US Forest Service PNW-FIA and US Forest Service FHP. We also provide selective media to collaborators, in particular UC Cooperative Extension in Humboldt - Del Norte Counties, to conduct their own *Phytophthora* isolations. We also provide species identification confirmations when *Phytophthora* species are recovered.

Additionally, as a service to other diagnosticians and researchers around the country, we continue to maintain a collection of *P. ramorum* (1,200+ isolates) and other *Phytophthora* species (450+ isolates). Maintenance of voucher cultures is essential for identification of *Phytophthora* species and this collection also serves as a resource for providing relevant *Phytophthora* cultures to researchers around the world (after determining they have the correct permits).

Kerri Frangioso continues to work with management and outreach in the Big Sur-San Luis Obispo area. Because of COVID-19 precautions and statewide fires, outreach opportunities were reduced from typical years. Frangioso supported SOD Blitzes in the Monterey/Carmel area. In addition, she spent several days working with a film crew producing a documentary on forest recovery from fire. In particular, the crew in Big Sur focused on the impacts of SOD on fire.

The 2020 field season focused on SOD disease and mortality in northern California (Sonoma, Mendocino, Humboldt, Del Norte Cos.). This consisted of revisiting plots originally set up in 2004-2005 and last sampled in 2012. The goal was to update mortality estimates originally presented in Cobb et al. 2020.

During the field season, 59 plots were re-visited. Based on 87 samples across 43 plots, 8 plots tested positive for the first time:

- Sonoma State's Galbreath Wildlands Preserve (Sonoma County) 4 new positive plots
- Salt Point State Park (Mendocino County) new site
- Russian Gulch State Park (Mendocino County)
- Private Property in Whitethorn (Southern Humboldt County) new site.

This did not change the range of SOD but began to fill in new areas. We had hoped to sample additional plots in Salt Point State park and Kruse Rhododendron Preserve; however, access was cut off due to fire in late August.

Fire impacted many of our monitoring plots throughout coastal forests. Based on National Interagency Fire Center (NIFC) maps, 126 of our plots burned in 2020. Most of these plots have not been revisited in a long time (e.g., 2001, 2004) although some were sampled this year just before the fire. These plots include:

- 79 in Big Sur Dolan Fire (see below) (62 in our primary Big Sur network plus an addition 17 plots that have not been sampled in a while)
- 22 in Big Basin State Park
- 1 in Pt Reyes
- 24 Armstrong Redwoods/Austin Creek (3 plots sampled in 2020)

In our Big Sur *P. ramorum* Plot Network, 154 plots have been resurveyed since establishment. Only 34 of these have not tested positive for the pathogen and only 24 have not burned (see attached figure). In the Dolan Fire in 2020, 62 plots in this network burned: 31 in Redwood forest types and 31 in mixed-evergreen forest types, dominated by coast live oak (Figures 6-8).

Reference. Cobb RC, Haas SE, Kruskamp N, Dillon WW, Swiecki TJ, Rizzo DM, Frankel SJ, Meentemeyer RK. 2020. The Magnitude of Regional-Scale Tree Mortality Caused by the Invasive Pathogen *Phytophthora ramorum*. Earth's Future 8: e2020EF001500.

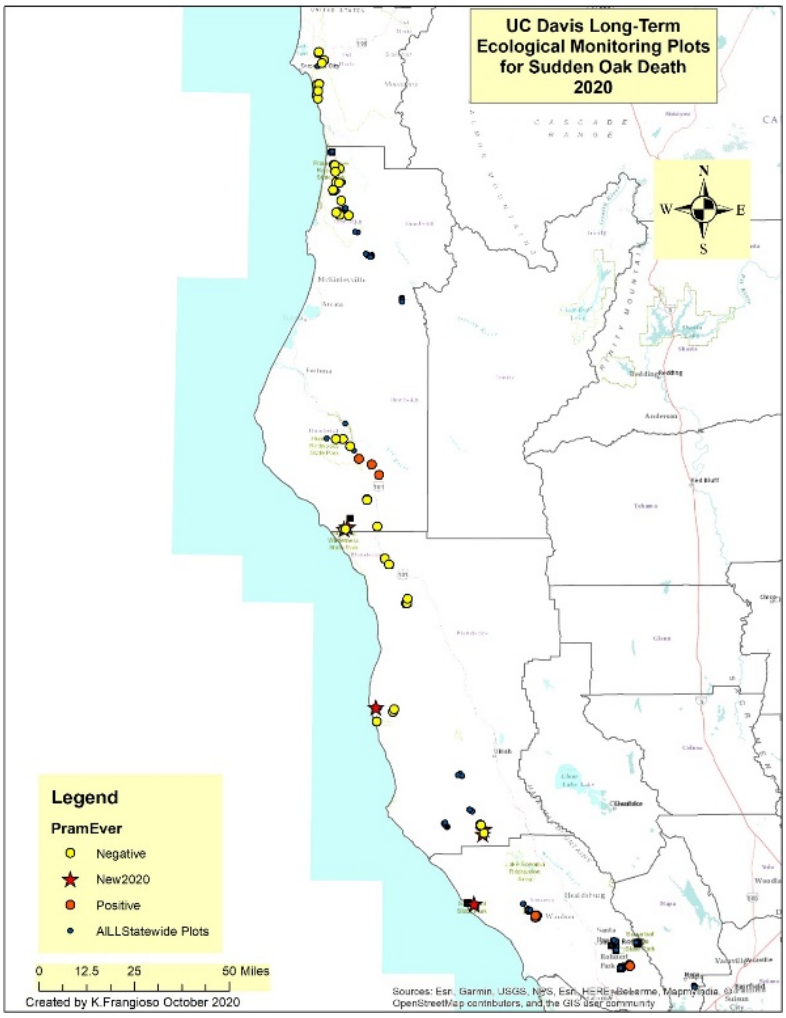

Fig.5. Results from sampling of northern California plots for *P. ramorum* caused mortality.

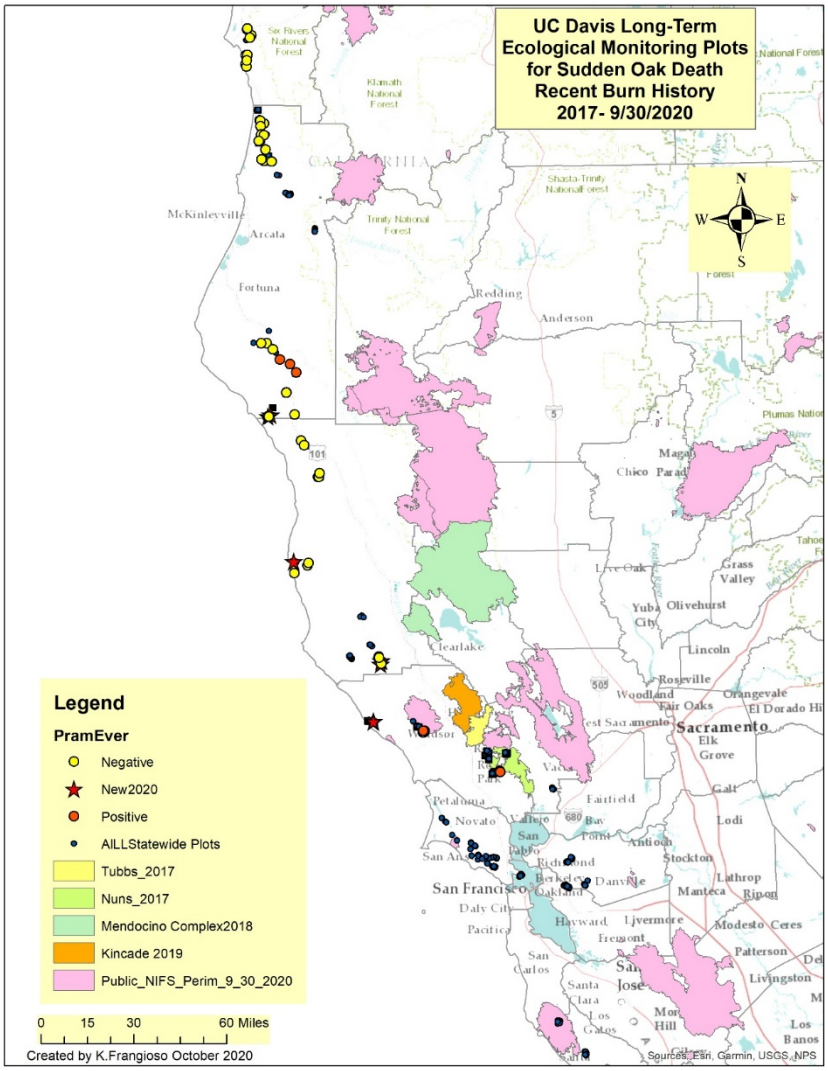

Figure 6. SOD-monitoring plots and recent burn history.

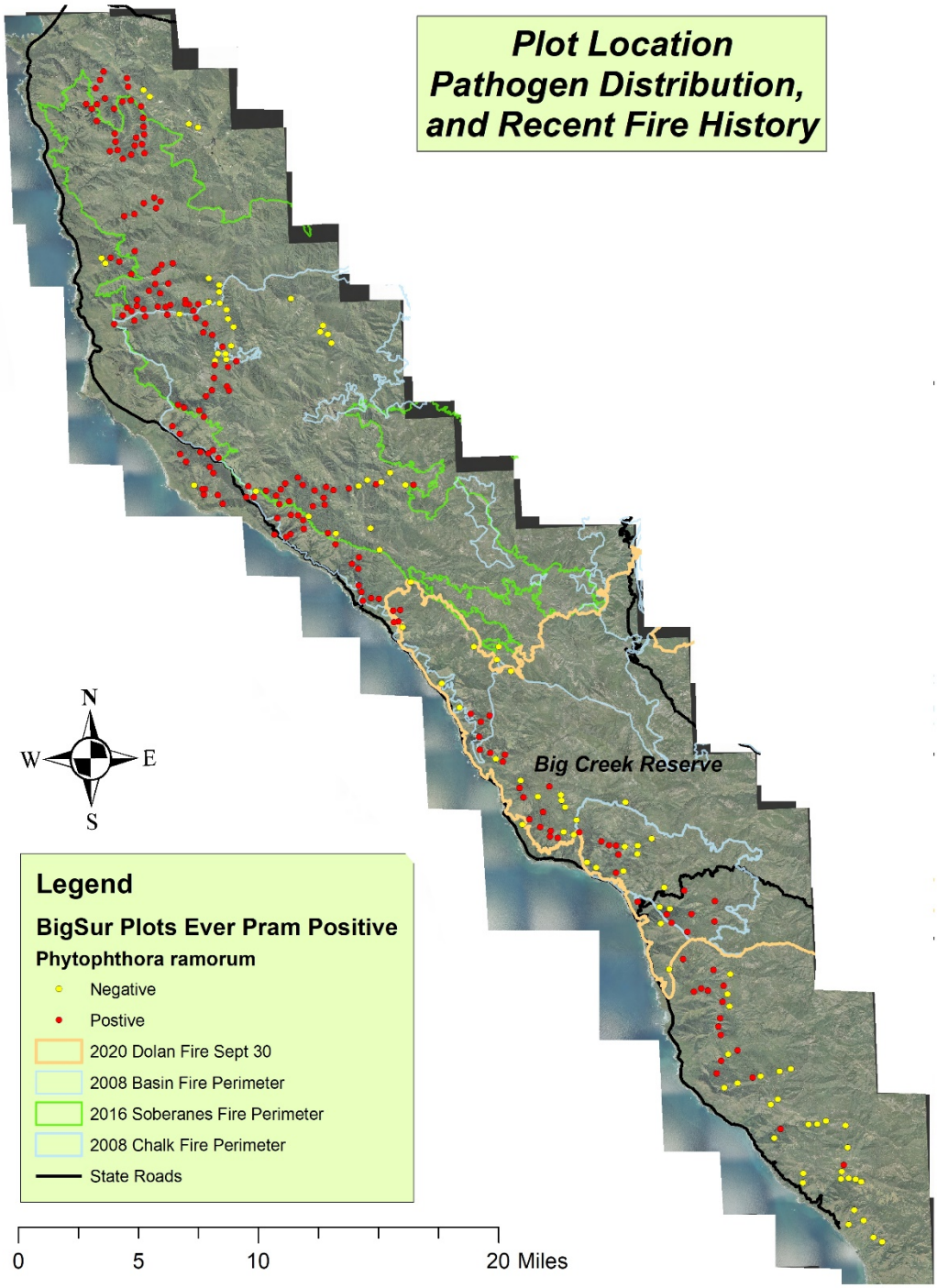

Figure 7. Big Sur plot network including pathogen distribution and recent fire history (Basin, Chalk, Soberanes, Dolan fires).