CALIFORNIA OAK MORTALITY TASK FORCE REPORT
FEBRUARY 2022

Editor's note. In this issue we look back at 2021 to provide a review of *Phytophthora ramorum*/sudden oak death (SOD) status and management. For many sections, tables and statistics are available by following the links.

2021 CALIFORNIA *PHYTOPHTHORA RAMORUM* IN WILDLANDS SUMMARY

In 2021, the incidence of new *Phytophthora ramorum* infections statewide on California bay laurel and tanoak leaves was at a historic low in California, based on the 2021 SOD Blitz, with an estimated general infection rate of 3.3% compared to 7.4% in 2020. Aerial surveys also found less tree mortality with approximately 20,000 acres of tanoak mortality attributed to *P. ramorum* recorded by the U.S. Forest Service (USFS), Forest Health Protection flights. Localized pockets of sudden oak death expansion were observed, but overall, significantly fewer dead trees were recorded than in the previous two years, because the wave of mortality sparked by the very wet 2016-2017 winter has subsided and has been followed by several years of drought.

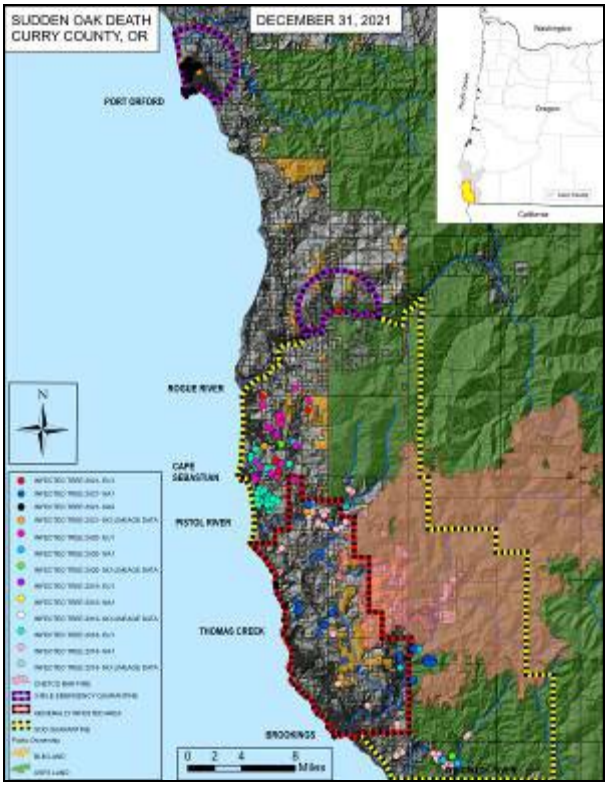
In Del Norte Co., the EU1 strain was again detected on tanoaks along State Route 197: two PCR detections were identified based on nuclear ITS and mitochondrial Cox I DNA. The EU1 lineage, considered more aggressive on conifers than the NA1 strain, was officially first confirmed at this location in 2020. Late that year, to eradicate or slow the EU1 infestation, host trees were removed, and herbicide applied to remaining tanoak root systems to prevent resprouting. Tanoaks in the surrounding area were also treated with herbicide, then removed after treatment along State Route 197 because the snags were deemed a future hazard. The detected strain is genetically consistent with EU1 isolates from Oregon forests, the only U.S. state in which it has been previously found in wildlands. The NA1 strain was not detected this year in Del Norte Co. The first *P. ramorum* detection in Del Norte Co. was an NA1 strain isolate collected in Jedediah Smith State Park in 2019. The area has been resampled, but the pathogen was not detected in 2021.

A California SOD 2021 *P. ramorum* status report is available HERE. Results from the citizen science SOD Blitz surveys, held under the direction of Matteo Garbelotto, are available from the UC Berkeley, Forest Pathology and Mycology Lab; the 2021 Forest Service, California aerial survey results are available from the USFS Pacific Southwest Region. Additionally, more details of *P. ramorum* status in California in 2021 are pending publication in the annual California Forest Pest Conditions report. For more information contact Chris Lee, christopher.lee@fire.ca.gov.

2021 OREGON *PHYTOPHTHORA RAMORUM* IN WILDLANDS SUMMARY

In 2021, the Oregon SOD program found two new infestations of *P. ramorum* outside the state SOD quarantine area. The first, detected in March, was on the Rogue River-Siskiyou National Forest along the north bank of the Rogue River, six miles north of any previously known infestation. Infected trees were identified by interpretation of high-resolution aerial imagery as a part of the annual USFS and Oregon Department of Forestry (ODF) Aerial Detection Survey. Cutting and piling of all tanoaks within the 600-ft treatment buffer was completed mid-May, and burning is ongoing as weather conditions permit.

The second infestation, just outside Port Orford, 21 miles northwest of the Rogue River and 13 miles south of Coos Co., was detected April 27th along Highway 101 by Oregon State University (OSU) Researcher Ebba Peterson. All samples collected have tested positive for the NA2 variant of *P. ramorum*. Previously found only in nurseries, this is the first time this variant has been found in wildlands. This infestation is the program's top priority: ODF, USFS, and OSU have surveyed over 400 acres with ground transects and collected over 200 samples, resulting in 154 positive detections. Samples were confirmed to species by the LeBoldus Lab, OSU and lineage determined by the Grunwald Lab at USDA Agricultural Research Service. Given the number of infected trees and new variant, Oregon SOD pathologists believe this to be a separate introduction to Oregon forests that has been intensifying in the area for at least 4 years. A tentative 600-ft treatment buffer has been placed around the confirmed positive trees, totaling 581 acres of proposed treatment. ODF has begun treatment on 208 acres within the proposed treatment area and will continue treatments as weather and fire risk conditions allow.



Left. Figure 1. Map of *P. ramorum* detections and quarantine areas in Oregon.
Right. Figure 2. ODF SOD Forester Vimal Golding sampling a tanoak by the Elk River near Port Orford. Credits: ODF.

Throughout 2021, other SOD survey and detection efforts continued in and adjacent to the SOD quarantine area, including monitoring 58 stream bait sites, aerial imagery interpretation of 379,000 acres, and 662 acres of ground transect surveys for the harvesting of disease-free tanoak. Two separate 3-mile emergency quarantines have been put into place by ODA until the extent of the new infestations has been determined (Figs. 1 & 2). Oregon's SOD program will consult with stakeholders regarding the expansion of quarantine boundaries in early 2022. The Oregon State Legislature appropriated $1.7 million to ODF to carry out an integrated pest

management program to combat SOD with $50,000 set aside to fund the OR SOD Task Force. The goal of Oregon's SOD program since 2010 has been to slow the spread of the disease, recognizing that eradication in the generally infested area of Curry Co. is not feasible. For more information contact Sarah Navarro, sarah.navarro@usda.gov.

NURSERIES AND MANAGED LANDSCAPES

California Department of Food and Agriculture (CDFA) *P. ramorum* program: 2021 summary report. In California, three nurseries were confirmed with *P. ramorum* positive plants in 2021. This number is down from five positive nurseries in 2020 (Table 1). The USDA "Official Regulatory Protocol for Nurseries Containing Plants Infected with *Phytophthora ramorum* Confirmed Nursery Protocol" (CNP) was implemented at all the positive nurseries. One nursery that shipped plants interstate was found to be positive. This nursery will continue to receive enhanced inspections where over 300 foliar samples are collected biannually. There are currently eight California nurseries receiving enhanced biannual inspections.

In 2021, approximately 6,800 *P. ramorum* regulatory samples were submitted to the CDFA Plant Pest Diagnostics Laboratory. A total of 156 samples were determined to be positive for *P. ramorum*, all from foliar samples. Positive plant species consisted of *Camellia* sp., *Loropetalum chinense*, *Rhododendron* sp., and *Viburnum tinus*.

Table 1. *P. ramorum*-Positive Nurseries by Year

Year	Nonquarantine Counties		Quarantine Counties		Total
	Production	Retail	Production	Retail	
2021	1		2		3
2020	2		3		5
2019	2	3	5	5	15
2018	2	3	2	4	11
2017	1	3	5	7	16
2016	1			1	2
2015					0

A more complete 2021 summary is available HERE. For more information contact Carolyn Lambert, Carolyn.Lambert@cdfa.ca.gov.

Oregon Department of Food and Agriculture (ODA) *P. ramorum* program: 2021 summary report. In 2021, the Oregon *P. ramorum* nursery program worked with eight interstate shippers under federal compliance agreements (7 CFR 301.92). The nurseries are in Polk (1 nursery), Washington (1 nursery), Marion (4 nurseries), Columbia (1 nursery), and Linn (1 nursery) Cos.

Four nurseries tested positive for *P. ramorum,* and the Confirmed Nursery Protocol (CNP) has been conducted at all the nurseries. ODA collected 3,547 foliar samples; 96 tested positive for *P. ramorum* (Figs. 3 & 4). Thirty soil samples and five water samples all tested negative. Most of the positive plants were rhododendrons or azaleas. A list of cultivars that tested positive and more detailed sampling information is available HERE. For more information contact Chris Benemann, sbenemann@oda.oregon.gov. Thanks also to Kaitlin Gerber, ODA for her assistance with this report.

Figures 3 & 4. Foliar symptoms on confirmed *P. ramorum* positive rhododendrons. Credit: ODA.

Washington State Department of Agriculture (WSDA) *P. ramorum* program: 2021 review. A summary of 2021 WSDA *P. ramorum* activities for nurseries, residences, and a botanic garden is available HERE. Over 1,200 samples were taken with only three positives, all from water collected at a botanic garden in Kitsap Co. For more information contact Scott Brooks at SBrooks@agr.wa.gov.

Table 2. 2021 Sample summary for *P. ramorum* in Washington state.

TOTAL SAMPLING IN 2021

Total number of regulatory samples collected (all sites)	1262
Total number of nursery samples collected	827
Total number of non-nursery samples collected	435
Total number of confirmed positive PLANT samples (2021)	**0**
Total number of confirmed positive WATER samples (2021)	**3**

SAMPLING (Botanic Garden)

Total number of samples collected	268
Total number of confirmed positive plant samples	0
Total number of confirmed positive water samples	3

SAMPLING (WA Department of Natural Resources stream baiting tested by WSDA)

Total number of DNR stream baiting samples collected	78
Total number of DNR confirmed positive water samples	0

RESEARCH

Bussell, E.H. and Cunniffe, N.J. 2022. Optimal strategies to protect a sub-population at risk due to an established epidemic. Journal of the Royal Society Interface. 19(186): 20210718. https://doi.org/10.1098/rsif.2021.0718.

Epidemics can particularly threaten certain sub-populations. For example, for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the elderly are often preferentially

protected. For diseases of plants and animals, certain sub-populations can drive mitigation because they are intrinsically more valuable for ecological, economic, socio-cultural or political reasons. Here, we use optimal control theory to identify strategies to optimally protect a 'high-value' sub-population when there is a limited budget and epidemiological uncertainty. We use protection of the Redwood National Park in California in the face of the large ongoing state-wide epidemic of sudden oak death (caused by *Phytophthora ramorum*) as a case study. We concentrate on whether control should be focused entirely within the National Park itself, or whether treatment of the growing epidemic in the surrounding 'buffer region' can instead be more profitable. We find that, depending on rates of infection and the size of the ongoing epidemic, focusing control on the high-value region is often optimal. However, priority should sometimes switch from the buffer region to the high-value region only as the local outbreak grows. We characterize how the timing of any switch depends on epidemiological and logistic parameters, and test robustness to systematic misspecification of these factors due to imperfect prior knowledge.

Funahashi, F.; Myrold, D.D.; Parke, J.L. 2021. The effects of soil solarization and application of a *Trichoderma* biocontrol agent on soil fungal and prokaryotic communities. Soil Science Society of America Journal. https://doi.org/10.1002/saj2.20361.

Soil solarization and biological control are two management strategies that have been used globally to manage soilborne plant pathogens. However, the broader effects of these strategies on soil microbial communities have not been well described. Soil prokaryotic and fungal communities were investigated by environmental DNA amplicon sequencing as part of field trials conducted in San Rafael, CA and in Corvallis, OR. We examined microbial community changes following soil solarization, amendment with the biocontrol agent *Trichoderma asperellum* (TA), or solarization followed by application of the biocontrol agent. Soil solarization caused significant changes to prokaryotic and fungal communities by reducing species richness and diversity. Soil water potential was determined to be a significant factor affecting the prokaryotic community. Application of TA to solarized or non-solarized soil did not significantly alter the microbial communities. However, solarization resulted in diminished microbial densities which appeared to enhance subsequent establishment of the biocontrol agent. This study revealed how specific environmental variables of heat intensity and soil moisture contribute to changes in the abundance of individual taxa and taxonomic groups.

Schweigkofler, W.; Pastalka, T.; Abeysekara, N.; Huffman, V. and Suslow, K. 2021. Transmission of the invasive pathogen *Phytophthora ramorum* from symptomatic to healthy host plants during a five-year period in California. Plant Health Progress. PHP-06. https://doi.org/10.1094/PHP-06-21-0089-RS.

Reliable data on the transmission of airborne plant pathogens are crucial for the development of epidemiological models and implementation of management strategies. The short-distance vertical transmission of the forest pathogen *Phytophthora ramorum* from a symptomatic California bay laurel (*Umbellularia californica*) to healthy containerized rhododendrons (*Rhododendron caucasicum* × *R. ponticum* var. *album*) was monitored for five winters (2016/17 to 2020/21) in a field experiment in Northern California. Transmission events were observed during four winters at a frequency of 1 to 17 per season, but not during the extremely dry winter of 2020/21, and were positively correlated to total rainfall rates. The first leaf symptoms were

detected around mid-December and reached the highest numbers in January of most years. Only limited symptom development was observed in the spring, with the last detections in May. The exposure time (the time between the first rainfall after placing a bait plant under the bay laurel and development of symptoms) varied between 3 and over 150 days, with an average between 14 and 21 days. *P. ramorum* was detected from water samples collected from the canopy of the symptomatic California bay laurel. No horizontal pathogen spread was detected from symptomatic to healthy rhododendrons placed at a distance of 2 to 6 m.

Uzunovic, A.; Kus, S.; Hook, A. and Leal, I. 2021. Potential of the fumigant ethanedinitrile to kill the pinewood nematode (*Bursaphelenchus xylophilus*) and other forest pathogens. Forest Pathology. e12723. https://doi.org/10.1111/efp.12723.

A screening test was carried out using ethanedinitrile (EDN) as a candidate fumigant to replace methyl bromide for efficacy against a selection of forest pests, including the pinewood nematodes (*Bursaphelenchus xylophilus*) and four tree pathogens: *Heterobasidion annosum*, *Geosmithia morbida*, *Phytophthora ramorum* and *Ceratocystis fagacearum*. Two EDN concentrations were tested: 50 and 100 g/m^3 at two different temperatures and six exposure times. In our tests, EDN was very efficient in killing pathogens in all test parameter combinations, including short exposure times and lower concentration, apart from *C. fagacearum* surviving short 1 h exposure and *G. morbida* surviving after 1 and 3 h of exposure.

RELATED RESEARCH

Burgess, T.I.; Edwards, J.; Drenth, A. and others. 2021. Current status of *Phytophthora* in Australia. Persoonia. 47: 151–177. https://www.ingentaconnect.com/content/nhn/pimj/pre-prints/content-nbc-persoonia-0611.

Feau, N.; Mcdonald, M.; Van Der Meer, B.; Zang, Y.; Herath, P. and Hamelin, R.C. 2022. *Phytophthora* species associated with red alder dieback in British Columbia, Canada. Canadian Journal of Plant Pathology. Early view. https://doi.org/10.1080/07060661.2021.2022763.

Green, S.; Cooke, D.E.; Dunn, M.; Barwell, L.; Purse, B.; Chapman, D.S. and others. 2021. PHYTO-THREATS: Addressing threats to UK forests and woodlands from *Phytophthora*; identifying risks of spread in trade and methods for mitigation. Forests. 12(12): 1617. https://doi.org/10.3390/f12121617.

RESOURCES

Kline, N.; Elliott, M.; Parke, J.; Stark, D.; Shaw, D. and Christiansen, A. 2022. Preventing *Phytophthora* infestations in restoration nurseries: a key to protecting wildland plant communities. EM 9330. Oregon State University Extension Service. 38 pp. https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9330.pdf.