CALIFORNIA OAK MORTALITY TASK FORCE REPORT
JUNE 2020

MONITORING

Is that leaf spot caused by *Phytophthora ramorum*? Spring is a favored time for *P. ramorum* surveys, and searching for leaf spots on California bay laurel, *Umbellularia californica,* is the preferred method for early detection in California. However, many other fungal leaf spots look similar to those caused by *P. ramorum*. Here, we provide pointers to avoid a common look-alike, *Cylindrocladium*/*Calonectria* sp. nov.

Cylindrocladium/Calonectria sp. nov. has been identified on bay laurel from Del Norte County along the coast into Sonoma, Santa Clara and Santa Cruz Counties. The two genus names represent the asexual stage, *Cylindrocladium* and sexual stage, *Calonectria* of this fungus ("sp. nov." simply means it appears to be a "new," undescribed species). The following characteristics may help distinguish it from *P. ramorum* infection. First, the infection may occur throughout much of the bay laurel crown, sometimes affecting over 50% of the leaves. In contrast, *P. ramorum* symptoms usually show up on the lower or innermost parts of bay laurel crowns where humidity is highest and temperatures are moderated.

Left: Leaf spots caused by *Cylindrocladium*/*Calonectria* sp. nov. on *Rhododendron macrophyllum.* Photo: C. Lee, CALFIRE. Right: California bay laurel with symptoms of *P. ramorum* infection. Photo: K. Peek, Alameda County Department of Agriculture.

Second, the lesions caused by *Cylindrocladium/Calonectria* sp. nov. are often blacker and cover a larger portion of the leaf than symptoms of *P. ramorum*. For comparison, on bay laurel, *P. ramorum* leaf spots typically appear as brown tips often with an uneven (wavy) dark grayish or chlorotic (yellow) margin. Tiny spots can often be seen above the larger leaf tip lesion. The damage is usually located where water collects on the leaf and can be small, less than 0.25 inches at its widest point. Note that bay laurel are not killed by *P. ramorum* infection, but this tree species is the primary source of inoculum, so it serves as an important contributor to pathogen spread from tree to tree. Collected leaves or twigs need to be disposed of carefully to avoid inadvertent pathogen transport.

According to the USDA Agricultural Research Service Mycological Database, 164 species of fungi or oomycetes have been identified from California bay laurel. Laboratory testing is needed to definitively identify which pathogen is causing a particular leaf spot. *This is the first in a series on P. ramorum look-alikes that will be featured in future issues of the COMTF News.*

REGULATIONS

Last summer the National Plant Board (NPB) requested USDA APHIS Plant Protection and Quarantine (PPQ) conduct a review of communications and operations for the *P. ramorum* regulatory program. In response, a "*Phytophthora ramorum* 2019 Season Hotwash Report" was issued on March 11, 2020. The report reviewed confirmation and trace activities for the U.S. *P. ramorum* regulatory program that occurred during calendar year 2019 as a result of two major trace events.

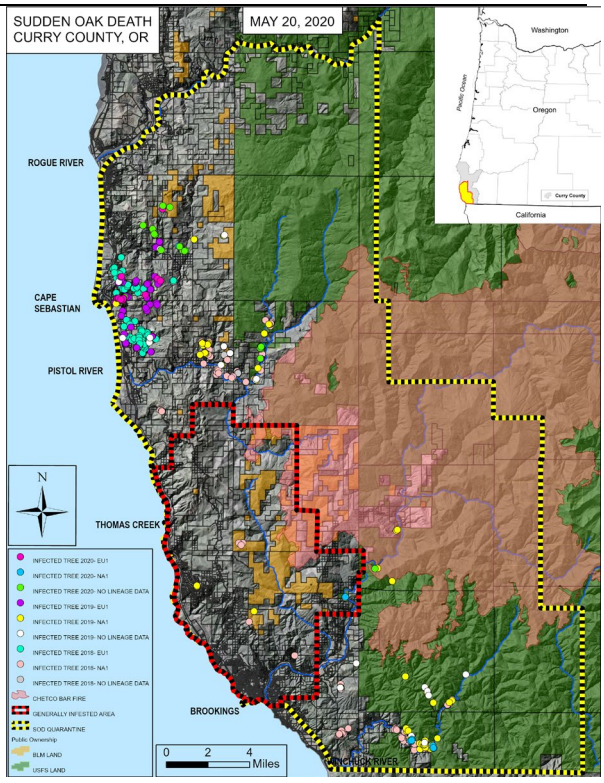
In 2019, federal labs confirmed over 250 positive samples of *P. ramorum* from 14 states. PPQ and state regulators identified two nurseries as the major source of these positive plants. Trace-back information revealed that the two source nurseries had potentially shipped infected plants to 28 states. These two events became part of the largest trace-forward investigation for the U.S. *P. ramorum* program in any single year for over a decade.

In October 2019, the joint working group for *P. ramorum*, comprised of members from the NPB and PPQ, met in Sacramento. The PPQ *P. ramorum* Cross Functional Working Group collected and reviewed data from the PPQ State Plant Health Directors and State Plant Regulatory Officials about events involving confirmation and trace activities for the *P. ramorum* program that occurred during 2019. A full program review is planned to begin later this year.

The Cross Functional Working Group reviewed the 2019 program manual, and a new, revised *Phytophthora ramorum* Domestic Regulatory Program Manual has been posted for 2020. The retail protocol for *P. ramorum* detections is currently under review. There have been no major trace forwards reported to date in 2020.

MANAGEMENT

***Phytophthora ramorum* Wildland Management in Oregon** –To date in 2020, 15 new infestations have been detected at or beyond the Oregon Generally Infested Area (GIA). Using a 300 ft treatment buffer, 2020 treatment areas total approximately 76 acres of private land, 80 acres on Bureau of Land Management lands, 42 acres on State Park lands, and 40 acres on U.S. Forest Service lands. Progress for Oregon's Slow-the-Spread Program for the management of Sudden Oak Death is updated on a monthly basis on the "Oregon SOD Program Dashboard." The map (right) shows detections through May 2020.



Oregon's SOD stream baiting program commenced in early April with 38 stream drainages inside and outside the SOD quarantine area to be monitored this year. Given the COVID-19 related downturn in state revenues, the Oregon Department of Forestry (ODF) was asked to prepare a plan for an 8.5% reduction to the biennial General Fund allotment. ODF is awaiting final direction on budget reductions, but under this plan Sudden Oak Death Treatment funding would be decreased by $214,500. For more information, contact Sarah Navarro, Sarah.Navarro@oregon.gov.

NURSERIES

California Department of Agriculture *P. ramorum* program update. Spring compliance inspections at previously positive nurseries have been completed. Ten California nurseries that were previously positive for *P. ramorum* and that ship host material interstate were inspected and sampled for quarantine compliance. *P. ramorum* was detected in three of the nurseries on *Loropetalum chinense* and *Camellia* sp. This brings the total number of positive nurseries in California to five. The five California nurseries positive for *P. ramorum* in 2020 are undergoing the USDA's Official Regulatory Protocol for Nurseries Containing Plants Infected with *Phytophthora ramorum*. Trace investigations for four of the nurseries have been completed with no additional positive plants detected. Trace investigations for the fifth nursery are still ongoing. For more information contact, Carolyn Lambert, Carolyn.Lambert@cdfa.ca.gov.

Oregon Department of Agriculture (ODA) *P. ramorum* program update. Spring compliance surveys for interstate nurseries have been completed with no *P. ramorum* detected. For the six intrastate nurseries, four have been sampled with no *P. ramorum* detections. The remaining two will be sampled by the end of May. Thus far, 1,935 foliar samples have been sampled and tested as part of compliance surveys.

A retail nursery in Multnomah County completed laying a cement slab in the portion of the nursery where confirmed positive plants and soil had been detected. ODA staff recommended cementing over the area if regulated plants would be placed in this part of the nursery.

Planned summer 2020 field activities include conducting soil steaming at three nurseries where infested soil was previously detected. The nurseries are located in Washington and Marion Counties. For more information, contact Chris Benemann, sbenemann@oda.state.or.us.

Washington State Department of Agriculture *P. ramorum* program update. In April, a water sample was confirmed positive at a nursery in the *P. ramorum* compliance program. The sample was collected using the "Bottle of Bait" method during their certification survey in March. Additional vegetation and water sampling is scheduled for May.

A positive water bait sample collected by the Washington Department of Natural Resources (WA-DNR) on Evans Creek in Snohomish County is pending confirmation with the USDA APHIS laboratory. Every year the WA-DNR places baits in various waterways in Washington to monitor for *P. ramorum*. Follow up with two nurseries in the Evans Creek drainage is planned. One of the nurseries has been previously positive for *P. ramorum*.

A spring survey at the Kitsap County Botanical Garden has been postponed, since the site is temporarily closed due to COVID-19 restrictions. For more information contact, Scott Brooks, SBrooks@agr.wa.gov.

RESEARCH

Over a hundred previously unknown *Phytophthora* species have been identified by European researchers collaborating in Pest Organisms Threatening Europe (POnTE). From 2013 to 2019, investigations of global diversity and biogeography of the genus *Phytophthora* were conducting in natural ecosystems of Japan, Taiwan, Vietnam, Indonesia, Chile, Nicaragua, Panama, Curacao, Egypt and 8 European countries; 320 forest sites, 410 forest streams, 9 mangrove forests, 6 lagoons and 5 other marine sites were sampled. Baiting assays and direct plating of necrotic plant tissues were used to isolate *Phytophthora* species from forest streams, forest soils and woody plants. Overall, 13,242 isolates were obtained, which could be assigned to 65 known and 101 previously unknown species of *Phytophthora*. Their findings include determining that two of the most damaging invasive *Phytophthora* species, *P. cinnamomi* and *P. ramorum*, are most likely native to Southeast Asia. The scientists recommend extensive host-range testing of forest tree and horticultural crop species to assess the potential threat posed by the import of living plants from Southeast Asia. Several presentations and factsheets with further information may be found at https://www.ponteproject.eu/.

RESEARCH – ABBREVIATED ABSTRACTS

Bussell, E.H. and Cunniffe, N.J. 2020. Applying optimal control theory to a spatial simulation model of sudden oak death: ongoing surveillance protects tanoak while conserving biodiversity. Journal of the Royal Society Interface. 17(165): 1720190671. https://doi.org/10.1098/rsif.2019.0671.

Sudden oak death has devastated tree populations across California. However, management might still slow disease spread at local scales. We demonstrate how to unambiguously characterize effective, local management strategies using a detailed, spatially explicit simulation model of spread in a single forest stand. This pre-existing, parameterized simulation is approximated here by a carefully calibrated, non-spatial model, explicitly constructed to be sufficiently simple to allow optimal control theory (OCT) to be applied. By lifting management strategies from the approximate model to the detailed simulation, effective time-dependent controls can be identified. These protect tanoak—a culturally and ecologically important species—while conserving forest biodiversity within a limited budget. We also consider model predictive control, in which both the approximating model and optimal control are repeatedly updated as the epidemic progresses. This allows management which is robust to both parameter uncertainty and systematic differences between simulation and approximate models. Including the costs of disease surveillance then introduces an optimal intensity of surveillance. Our study demonstrates that successful control of sudden oak death is likely to rely on adaptive strategies updated via ongoing surveillance. More broadly, it illustrates how OCT can inform effective real-world management, even when underpinning disease spread models are highly complex.

McCoy, A.G.; Miles, T.D.; Bilodeau, G.J.; Woods, P.; Blomquist, C.; Martin, F.N.; Chilvers, M.I. 2020. Validation of a preformulated, field deployable, recombinase polymerase amplification assay for *Phytophthora* species. Plants. 9: 466. doi: https://www.mdpi.com/2223-7747/9/4/466.

Recombinase polymerase amplification (RPA) assays are valuable molecular diagnostic tools that can detect and identify plant pathogens in the field without time-consuming DNA extractions. Historically, RPA assay reagents were commercially available as a lyophilized pellet

in microfuge strip tubes, but have become available in liquid form more recently—both require the addition of primers and probes prior to use, which can be challenging to handle in a field setting. Lyophilization of primers and probes, along with RPA reagents, contained within a single tube limits the risk of contamination, eliminates the need for refrigeration, as the lyophilized reagents are stable at ambient temperatures, and simplifies field use of the assays. This study investigates the potential effect of preformulation on assay performance using a previously validated *Phytophthora* genus-specific RPA assay, lyophilized with primers and probes included with the RPA reagents.

Rooney-Latham, S.; Blomquist, C.L.; Soriano, M.C. and Uhler, M. 2020. First Report of *Phytophthora ramorum* causing foliar and stem blight of two California native *Arctostaphylos* species, *A. viridissima* and *A. glauca*. Plant Disease. First Look. https://doi.org/10.1094/PDIS-07-19-1359-PDN.

The genus *Arctostaphylos* (Ericaceae) [common name manzanita] includes more than 100 species of evergreen shrubs and small trees, most of which are endemic to California and many considered threatened or endangered. In May and June 2017, foliar and stem samples of two *Arctostaphylos* species were submitted for disease diagnosis to the CDFA Plant Pest Diagnostics Center. The only symptomatic *A. glauca* plant was collected from a native plant nursery in Contra Costa Co. while the only symptomatic *A. viridissima* plant was collected from a botanical garden less than 5 km away. Leaves exhibited necrotic spots, some of which extended into the stems as cankers. An organism resembling *P. ramorum*, with coralloid coenocytic hyphae, chlamydospores, and ellipsoidal semipapillate sporangia, was isolated from many of the pieces of both hosts. The infected *A. viridissima* and *A. glauca* plants were collected in a region known to be infested with *P. ramorum*. To our knowledge, this is the first report of both species as hosts of *P. ramorum* and indicates their role in the spread of *P. ramorum* in nurseries and wildlands should be further studied.

Tooley, P.W.; Browning, M.; Vinyard, B. 2020. Diurnal effects on sporangium and zoospore production by *Phytophthora ramorum* on *Rhododendron* 'Cunningham's White'. Mycologia. DOI: https://doi.org/10.1080/00275514.2020.1728472.

We evaluated sporangium and zoospore production by three isolates of *Phytophthora ramorum* on *Rhododendron* 'Cunningham's White' leaves under light and dark conditions at both variable and constant (14° C) temperature. *P. ramorum*–infected leaves were detached and placed in funnels inside of a 62-L plastic storage container located in a growth chamber. Sporangia and zoospores were collected over a 4-day period by misting leaves with 5 mL of distilled water, which was collected in conical test tubes that also contained runoff from the misting. Spores were collected daily just before a 13-h light period and again just before an 11-h dark period. Large differences in sporangium and zoospore numbers observed for the dark versus light periods were observed on days 2, 3, and 4. A diurnal effect has been observed for production of propagules of other oomycetes, but such effects have not been previously reported for *P. ramorum*. This information will help provide a better understanding of patterns of inoculum production by *P. ramorum* and resulting fluctuations in inoculum density that will influence sudden oak death epidemics in forest ecosystems in the U.S. and other countries where it occurs.

RELATED RESEARCH

Boevink, P.C.; Birch, P.R.; Turnbull, D. and Whisson, S.C. *In press*. Devastating intimacy: the cell biology of plant–*Phytophthora* interactions. New Phytologist. https://doi.org/10.1111/nph.16650.

Redekar, N.R., Eberhart, J.L., Rooney-Latham, S., Blomquist, C.L. and Parke, J.L. 2020. First report of *Phytophthora tropicalis* causing foliar blight and shoot dieback of *Pieris japonica* in Oregon. Plant Disease. https://doi.org/10.1094/PDIS-10-19-2179-PDN.

Widmer, T.L.; McMahon, M.B.; Luster, D.G. 2020. Plant pathogenic fungi are harbored as endophytes in *Rhododendron* spp. native to the Eastern USA. Fungal Ecology. 47:100949. https://doi.org/10.1016/j.funeco.2020.100949

RESOURCES

California county maps showing the approximate locations of *P. ramorum* confirmed trees are now available at www.suddenoakdeath.org, Maps & Visual Media, Maps. The fifteen maps of infested California counties are based on SODMAP data compiled by UC Berkeley, Forest Pathology and Mycology laboratory, Matteo Garbelotto. The location data for positive detections is current through 2019.

White, S.A.; Majsztrik, J.; Pitton, B.; Swett, C.L. and Parke, J.L. 2020. Dialing down diseases. Plant disease risk management. Nursery Management (April issue). To help identify nursery practices associated with the greatest or least risk of disease problems, this article, a video and online tool, Disease Risk Model v 1.0. are available at Clean WateR3, https://occviz.com/CW3/pathogen/pathogen.html.

California oak health workshop videos presented by UC Cooperative Extension (UCCE) are now available online. Topics include: conservation of Oregon white oak and California black oak woodlands; post-fire survival and regeneration of California black oak, blue oak, and interior live oak; sudden oak death; root-rotting Phytophthoras; and the newly detected Mediterranean oak borer. The site also includes an area to pose questions to oak health specialists.

PEOPLE

Sarah Navarro will be the new Sudden Oak Death Pathologist for the U.S. Forest Service, Pacific Northwest Region, State and Private Forestry, Forest Health Protection. Sarah will guide and coordinate efforts to address the ongoing ecological and economic threat posed by the spread of sudden oak death in Oregon and Washington. Sarah is currently a technical and programmatic lead for *P. ramorum* and other forest pathogens with the Oregon Department of Forestry in Salem. Sarah will be stationed out of the Forest Service, Portland office starting June 22nd.

CALENDAR

The Phytophthoras in Native Habitats Work Group will meet via Zoom on Tuesday, June 30 at 1 pm PDT. Updates will include an infestation on rare manzanita in Sonoma County,

Phytophthora damage on trees throughout the North Coast, progress towards a restoration nursery accreditation program and more. For more information, contact, Janice Alexander, jalexander@ucanr.edu.