CALIFORNIA OAK MORTALITY TASK FORCE REPORT
JUNE 2014

NOTE: Distribution of the COMTF monthly newsletter is aligned with the California Board of Forestry and Fire Protection meeting calendar. As the Board has adjusted their schedule for 2014, the newsletter too will adjust accordingly. Therefore, the remaining 2014 reports will be distributed August 27, October 1, November 5, and December 10.

NURSERIES

Regulated states and the USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine have begun implementation of the revised protocols in *P. ramorum*-positive nurseries.

The Federal Order (FO) that took effect April 1 relieved regulatory requirements in CA, OR, and WA nurseries that have never been positive or have been negative for the past 3 years. Additional regulatory requirements are being implemented in nurseries positive since March 2011. Farm Bill funded National Surveys have also been initiated in 14 non-regulated states (AL, KY, LA, MD, MI, NC, NV, NY, OH, RI, TN, TX, VA, WV).

On average, 200 samples (including, plants, water, container mix, pots, etc.) are being collected from more than 20 nurseries in CA, OR, and WA that are impacted by the revised FO. Since March 31st, *P. ramorum* has been detected at six interstate shipping facilities (CA-1, OR-4, and WA-1) and four retail nurseries (OR-1, WA-1, and VA-2). Confirmed Nursery Protocols and trace investigations have been completed or are in progress at several of the nurseries. Efforts are underway to initiate critical control point assessments and implement mitigations at each positive nursery. *P. ramorum* positives were detected on: *Viburnum* (29); *Gaultheria (14)*; *Rhododendron* (14); *Pieris* (7); *Camellia* (5); water baiting (4); soil (3); *Syringa* (2); potting media (1); *Prunus* (1); and *Vaccinium* (1).

For more information on the regulatory protocols, go to http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/downloads/pdf_files/ConfirmedNurseryProtocol.pdf.

California had one *P. ramorum*-positive interstate (opt-in) shipping nursery confirmed in May. The infected *Camellia japonica*, *Syringa vulgaris*, and *Viburnum tinus* were identified at the Sacramento County facility during a compliance agreement inspection. The facility was also found positive in 2009, 2010, and 2011. The confirmed nursery protocol has been implemented, and trace-forward information has been provided to the USDA APHIS as well as California counties that received potentially infected plants.

Oregon has identified five *P. ramorum*-positive nurseries in 2014. One Marion County nursery is an intrastate (opt-out) shipper with infected *Pieris*, *Rhododendron*,

Leucothoe, and *Viburnum*. The other four nurseries are interstate (opt-in) shippers in Tillamook (positive *Gaultheria* and *Rhododendron*), Washington (positive *Rhododendron* and used potting media), Clackamas (positive *Pieris* and retention pond water), and Lane Counties (positive *Rhododendron*). The USDA Confirmed Nursery Protocol has been enacted at all four nurseries. Delimitation surveys to date have detected two infected *Rhododendron* plants in the Washington County nursery and three infected soil substrate samples from the Clackamas County nursery. Testing of additional delimitation samples is underway.

NOTE: Nurseries in the "regulated area" (WA, OR and non-quarantined CA counties) that have never been found *P. ramorum* positive since the inception of the regulation, or have been negative the past 3 years (since March 2011), are no longer subject to the USDA APHIS annual survey certification program; however, state run inspection and certification programs will continue in these nurseries. Nurseries positive since March 2011 may continue shipping interstate if they agree to new inspection, sampling, and other compliance program requirements. These are referred to as "opt-in" nurseries. Nurseries that "opt-out" have chosen not to ship *P. ramorum* host material interstate under the new requirements (http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/downloads/pdf_files/DA-2014-02.pdf). These nurseries will be inspected by the state as they can still move hosts intrastate and will not be on an "approved" host nursery list. In general, nurseries can ship interstate plants sourced from other "opt-in" nurseries or from those where *P. ramorum* has never been detected since the inception of the program or have been negative in the past 3 years.

FEATURE - RED NEEDLE CAST IN NEW ZEALAND, *PHYTOPHTHORA PLUVIALIS*

***Phytophthora pluvialis* is the primary cause of a new *Pinus radiata* (Monterey pine)** foliar disease in New Zealand. First recognized in the winter of 2008 in plantation forests on the North Island, early symptoms include discrete olive-colored lesions on needles, often with a narrow dark resinous band. The lesions develop further to result in rapid needle senescence and premature defoliation. The disease has been variable in incidence and severity both regionally and in different years, and has been termed "red needle cast" as affected trees have a reddish appearance prior to needle cast. Isolation from needles frequently yielded an unknown species of *Phytophthora*, which was subsequently found to be identical to *Phytophthora pluvialis*, a species in Oregon described by P. Reeser, W. Sutton and E. Hansen in 2013, where it is not associated with disease. Infection appears to be limited to the needles, with no recoveries of *Phytophthora pluvialis* from the roots, stems, or branches. Occasionally *P. kernoviae*, was also recovered from needles with the same symptoms.

A stand of *Pinus radiata* trees affected by red needle cast disease. Note the reddish appearance of affected trees prior to needle drop. (Photo from New Zealand Journal of Forestry Science.)

Dick, M.A.; Williams, N.M.; Bader, M.K.F.; Gardner, J.F.; and Bulman, L.S. 2014. Pathogenicity of *Phytophthora pluvialis* to *Pinus radiata* and its Relation with Red Needle Cast Disease in New Zealand. New Zealand Journal of Forestry Science. 44:6. 10.1186/s40490-014-0006-7.

Other recent *Phytophthora pluvialis/*red needle cast papers include:

Hood, I.A.; Williams, N.M.; Dick, M.A.; Arhipova, N.; Kimberley, M.O.; Scott, P.M.; and Gardner, J.F. 2014. Decline in Vitality of Propagules of *Phytophthora pluvialis* and *Phytophthora kernoviae* and Their Inability to Contaminate or Colonise Bark and Sapwood in *Pinus radiate* Export Log Simulation Studies. New Zealand Journal of Forestry Science. 44:7.

Rolando, C.; Gaskin, R.; Horgan, D.; Williams, N.; Bader, M.K.F. 2014. The use of Adjuvants to Improve Uptake of Phosphorous Acid Applied to *Pinus radiata* Needles for Control of Foliar *Phytophthora* Diseases. New Zealand Journal of Forestry Science. 44:8.

MONITORING

The US Forest Service aerial sudden oak death (SOD) survey flew approximately 460,000 acres in May in San Luis Obispo County as well as portions of Monterey, San Benito, Fresno, and Merced Counties. While large areas of tree mortality were seen throughout the surveyed area, the majority of the damage is believed to be drought related. In San Luis Obispo County, extensive coast live oak mortality 10 – 20 miles from the coast was observed in the Paso Robles area which is believed to be from the drought; however, 30 discrete areas of individual and small clumps of dead oak trees were also identified within 10 miles of the coast, and they will be ground checked for SOD. In Monterey County, ground surveys will be conducted for SOD in a Salmon Creek drainage with coast live oak and tanoak mortality that was identified just over a mile from the San Luis Obispo County line, and large areas of intense tanoak mortality were observed in a *P. ramorum*-infested area on the coast north of Salmon Creek. For more information on the aerial survey program, contact Zachary Heath at zheath@fs.fed.us.

MANAGEMENT

Two adaptive management projects are being conducted in Big Sur coast live oak-dominated forests to test the efficacy of bay laurel removal in infested coastal areas where SOD has been severe. These projects are the first of their kind to utilize UC Berkeley's SOD Blitz sampling. One project is in a small neighborhood where the homeowners association planned to remove all bay along a shared road and water easement in an effort to save their remaining coast live oak trees. UC Davis researchers engaged the community to help measure, map, and sample the bays. Instead of removing all bays, only those trees that test *P. ramorum* positive will be felled. The second project is along 500 meters of a trail at Pfeiffer Big Sur State Park, where all bay trees within 10 meters of the trail were measured, mapped, and sampled. All bay found positive for the pathogen will be removed as well as select bays within 10 meters of large oak trees.

By sampling during the current severe drought, researchers believe disease "hot spots" or reservoirs that support pathogen survival despite extremely dry, unfavorable conditions can be identified. Removal of these "hot spots" may help reduce the pathogen's population, thereby slowing its spread once more favorable conditions return. For more information on the Big Sur bay removal projects, contact Kerri Frangioso at kfrangioso@ucdavis.edu.

RESEARCH

Brockerhoff, E.G.; Kimberley, M.; Liebhold, A.M.; Haack, R.A. and Cavey, J.F. 2014. Predicting how Altering Propagule Pressure Changes Establishment Rates of Biological Invaders Across Species Pools. Ecology. 95(3): 594–601.

Abstract: Biological invasions resulting from international trade can cause major environmental and economic impacts. Propagule pressure is perhaps the most important factor influencing establishment, although actual arrival rates of species are rarely recorded. Furthermore, the pool of potential invaders includes many species that vary in

their arrival rate and establishment potential. Therefore, we stress that it is essential to consider the size and composition of species pools arriving from source regions when estimating probabilities of establishment and effects of pathway infestation rates. To address this, we developed a novel framework and modeling approach to enable prediction of future establishments in relation to changes in arrival rate across entire species pools. We utilized 13,828 border interception records from the United States and New Zealand for 444 true bark beetle (*Scolytinae*) and longhorned beetle (*Cerambycidae*) species detected between 1949 and 2008 as proxies for arrival rates to model the relationship between arrival and establishment rates. Nonlinearity in this relationship implies that measures intended to reduce the unintended transport of potential invaders (such as phytosanitary treatments) must be highly effective in order to substantially reduce the rate of future invasions, particularly if trade volumes continue to increase.

Garbelotto, M.; Barbosa, D.; Mehl, H.; and Rizzo, D.M. 2014. First Report of the NA2 Lineage of *Phytophthora ramorum* from an Ornamental Rhododendron in the Interior of California. Plant Disease. 98(6): 849.

In July 2012, we collected a rhododendron var. *Trilby* with twig dieback symptoms in the lower canopy, consistent with the disease "ramorum blight" caused by *Phytophthora ramorum*. The symptomatic plant had been planted a year earlier to replace a dead rhododendron in a landscape setting in Placer County, California (Lat: 39.036216°; Long: –120.999274°), Sierra Nevada foothills at ~600 m elevation. Isolations yielded a culture with a fast growth rate and overall morphology resembling the *P. ramorum* NA2 lineage described by Ivors et al. (4). DNA was extracted from the culture as described previously (4) and six SSR loci: MS18, MS39, MS43, MS45, MS64, MS145, were amplified (2,4). Allelic patterns were compared with those of three testers from each of the three lineages NA1, NA2, and EU1 known to be present in ornamental plants in North America, and they unambiguously confirmed the isolate belongs to the NA2 lineage of the pathogen. Although the symptomatic plant was confined to a landscape setting, it had been planted in that location for a year, providing a possible source of inoculum for the surrounding area. This is the first report of *P. ramorum* from the Sierra Nevada eco-region in the interior of California. It is also the first report of a NA2 isolate from a plant outside of commercial nurseries in California. The mating type of the isolate was not determined, but NA2 isolates are normally A2, the same mating type of NA1 isolates. The only other report of a NA2 isolate found outside of a nursery is from Washington State (1). Although there is no evidence the pathogen may have infected other plants, the infected rhododendron was found at a location situated over 100 km east of the closest known infestation (www.sodmap.org). Additionally, this is the first report of the pathogen outside the coast mountain range of California. Because the three lineages are genetically and phenotypically distinct (3), the escape of NA2 or EU1 isolates, both still absent from plants in natural settings, could have significant implications for California ecosystems. This finding highlights that introductions of *P. ramorum* via ornamental plants are still possible, in spite of current regulations.

References: (1) G. Chastagner et al. Phytopathology 101:S32, 2011. (2) P. P. Croucher et al. Biol. Invasions 15:2281, 2013. (3) N. J. Grünwald et al. Trends Microbiol. 20:131, 2012. (4) K. Ivors et al. Mol. Ecol. 15:1493, 2006.

Jung, T.; Brasier, C.M.; Sánchez, M.E.; Pérez-Sierra, A. (editors). 2014. Proceedings of the Sixth Meeting of the International Union of Forest Research Organizations (IUFRO) Working Party S07.02.09: Phytophthoras in Forests and Natural Ecosystems. 202 pp. Available online at http://www.forestphytophthoras.org/sites/default/files/proceedings/IUFRO%202014%20final%2023.8MB.pdf.

Abstract: The sixth meeting of the International Union of Forest Research Organizations (IUFRO) Working Party S07.02.09, Phytophthoras in Forests and Natural Ecosystems provided a forum for current research on *Phytophthora* species worldwide. One-hundred-and-forty submissions describing papers and posters on recent developments in *Phytophthora* diseases of trees and natural ecosystems in Europe, Australasia, and the Americas are included. Research topics covered are *Phytophthora* adaptation and evolution, climate change, diversity, ecology, ecophysiology, epidemiology, experimental taxonomy, geographic origins, invasion and spread, management, the nursery pathway, pathogenesis and resistance, and population biology.

Peterson, E.; Hansen, E.; and Hulbert, J. 2014. Source or Sink? The Role of Soil and Water Borne Inoculum in the Dispersal of *Phytophthora ramorum* in Oregon Tanoak Forests. Forest Ecology and Management. 322:48–57. Available online at http://dx.doi.org/10.1016/j.foreco.2014.02.031.

Abstract: Management of invasive species requires confidence in the detection methods used to assess expanding distributions, as well as an understanding of the dominant modes of spread. Lacking this basic biological information, during early stages of invasion management choices are often driven by available resources and the biology of closely related species. Such has been the case for the management of the phytopathogen, *Phytophthora ramorum*, causal agent of sudden oak death (SOD) of oaks and tanoaks. To detect *P. ramorum*, The Oregon SOD eradication program has relied upon the aerial observation of dead, overstory tanoak (*Notholithocarpus densiflorus*), an easily infected host widely distributed throughout the range of *P. ramorum* in Oregon. At risk is the possibility of misrepresenting the distribution of SOD, particularly if inoculum is predominately moved in soil and water, common dispersal pathways for other *Phytophthora* spp. To assess this risk, we performed surveys of understory vegetation in areas with a high risk of establishment of understory infection from soil and water sources: along roadsides within heavily trafficked areas with a history of SOD, and along streams known to contain *P. ramorum* inoculum. Additionally, we tested the alternative hypothesis of aerial dispersal, whereby infection in the understory would be spatially correlated with overstory mortality. Consistent with prior studies into the spatial structure of *P. ramorum* in Oregon, we found no evidence of understory infection in close proximity to roads in the absence of overstory mortality. Similarly, *P. ramorum* was only

isolated from understory vegetation associated with streams when within close proximity to overstory sources, and more commonly further away from stream edges than within the splash and flood line. Both disease patterns are inconsistent with a dominate soil and water mediated dispersal mechanism. Rather, we found evidence supporting our alternative hypothesis of aerial dispersal whereby recovery of *P. ramorum* in the understory declined with increasing distance from the only known overstory source. These results support the use of aerial detection in describing the distribution of SOD in Oregon, and give further support to dispersal of inoculum in blowing fog or rain at scales not yet described for other forest *Phytophthora* species.

Tooley, P.W.; Browning, M.; and Leighty, R.M. 2014. The Effect of Temperature on Germination of Chlamydospores of *Phytophthora ramorum*. Mycologia. 106: 424-430.

Abstract: Mycelium-free chlamydospores of 12 isolates of *P. ramorum* representing three clonal lineages were produced with a method involving incubation in nonsterile sand at 20 C in darkness for 30 d. Chlamydospores were incubated on selective agar medium at 5, 10, 15, 20, 25 and 30 C and germination assessed after 1, 2, 4, 6 and 8 d incubation. The optimal temperature for germination based on 8 d incubation was 20 C for all three clonal lineages tested (NA1, NA2, EU1). Mean germination rates were 2, 21, 44, 67, 32 and 0 percent at 5, 10, 15, 20, 25 and 30 C respectively for all isolates combined. The highest mean germination rate was scored by isolates of the EU1 clonal lineage at 20 C (85%) after 8 d incubation However, substantial variation was observed among isolates within each clonal lineage. Overall temperatures and days of incubation on which germination was assessed isolates of the NA1 clonal lineage had the lowest mean germination, even though one isolate had the highest germination of any isolate in any lineage. The results indicate that 20 C is the optimal germination temperature for *P. ramorum* chlamydospores and that a great disparity in germination percentage can exist within isolates, even within a single clonal lineage.

RELATED RESEARCH

Osterbauer, N.K.; Lujan, M.; McAninch, G.; Lane, S.; and Trippe, A. 2014. Evaluating the Efficacy of the Systems Approach at Mitigating Five Common Pests in Oregon Nurseries. Journal of Environmental Horticulture 32(1): 1–7.

Stack, J.P.; Bostock, R.M.; Hammerschmidt, R.; Jones, J.B.; and Luke, E. 2014. The National Plant Diagnostic Network: Partnering to Protect Plant Systems. Plant Disease. 98(6): 708-715.

van Hooff, J.J.E.; Snel, B.; and Seidl, M.F. 2014. Small Homologous Blocks in *Phytophthora* Genomes do not Point to an Ancient Whole-Genome Duplication. Genome Biology and Evolution. DOI: 10.1093/gbe/evu081.

RESOURCES

Frankel, S.J. and Palmieri, K.M. 2014. Sudden Oak Death, *Phytophthora ramorum*: A Persistent Threat to Oaks and Other Tree Species. International Oaks 25: 43-56.

This paper reviews the status and management of sudden oak death and sudden larch death in the urban and wildland forests of California, Oregon, and the United Kingdom. The causal pathogen, *Phytophthora ramorum* (Werres, De Cock & Man in't Veld), was discovered in all three locations over a decade ago. Despite professional, dedicated attempts, efforts to contain and eliminate infestations have been unsuccessful. These less than satisfactory management intervention outcomes underscore the importance of prevention, for once forest pathogens become established, response is costly and difficult, and eradication is unlikely. New approaches are needed to protect forests from invasive pathogens.

CALENDAR OF EVENTS

10/5 – 10/10 – IUFRO 2014 World Congress "Sustaining Forests, Sustaining People, The Role of Research;" Salt Lake City, Utah**;** For more information or to register, go to http://iufro2014.com/scientific-program/overview/ or contact John A. Parrotta atjparrotta@fs.fed.us.

11/3 – 11/6 - 7th California Oak Symposium; Visalia Convention Center, Visalia; For more information, go to http://ucanr.edu/sites/oaksymposium/.

11/10 – 11/14 - Seventh meeting of the IUFRO Working Party 7.02.09 "*Phytophthora* in Forests and Natural Ecosystems;" Esquel, Argentina. For more information, registration, or abstract submission details, go to http://www.iufrophytophthora2012.org/.

11/12 – 11/13 - 2014 Annual Meeting of the California Forest Pest Council; USDA Forest Service, Wildland Fire Training & Conference Center; 3237 Peacekeeper Way; McClellan; More information will be forthcoming. For more information, contact Katie Palmieri at kpalmieri@berkeley.edu.

1/13/15-1/17/15 – California Native Plant Society Conservation Conference; "Celebrating 50 Years of Progress and Promise;" Double Tree by Hilton, San Jose; 2050 Gateway Pl, San Jose; The Call for Abstracts closes July 10th. Early Registration opens July 15th. For more information, go to http://www.cnps.org/cnps/conservation/conference/2015.