CALIFORNIA OAK MORTALITY TASK FORCE REPORT
SEPTEMBER 2017

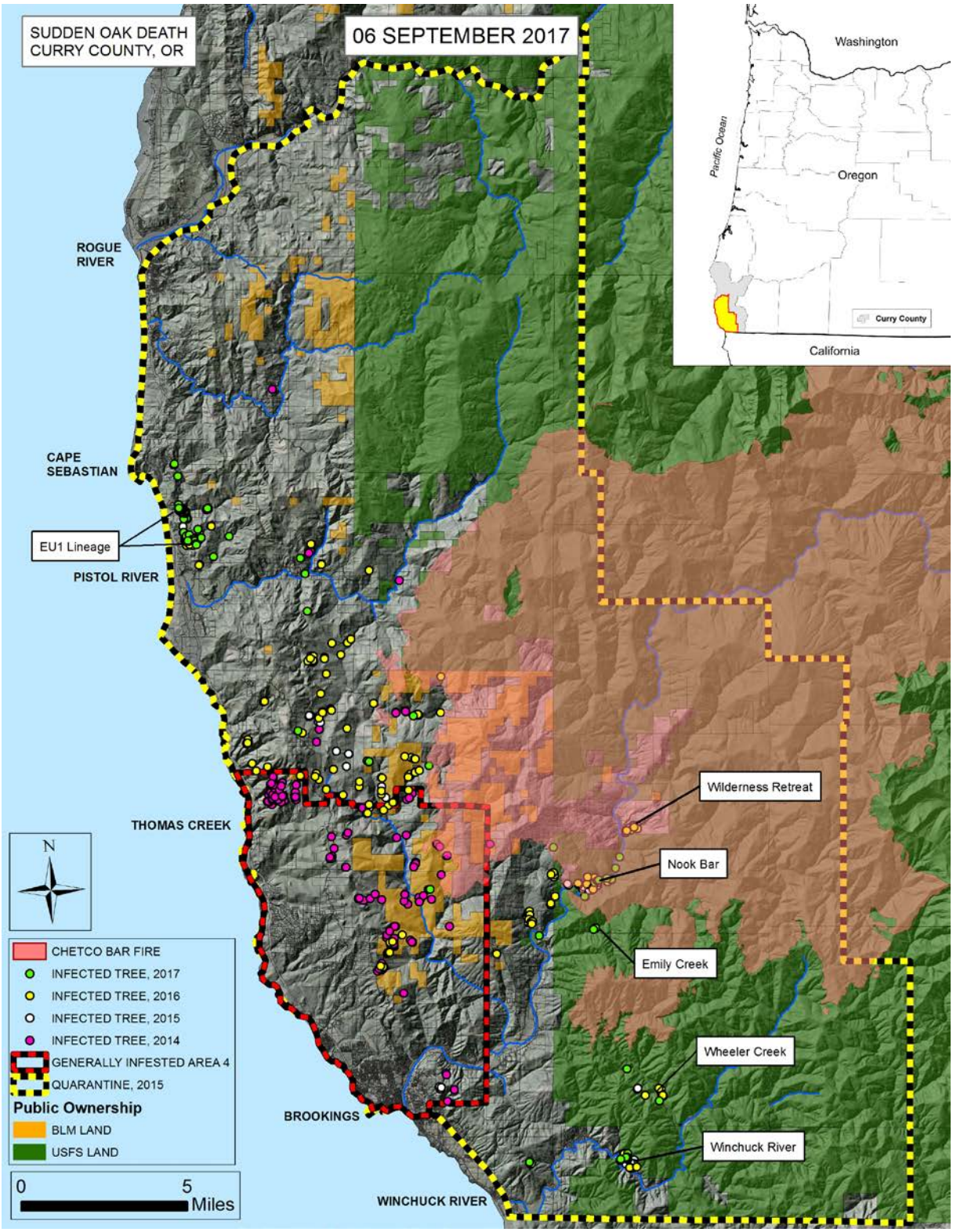
NURSERIES

California has had 17 *Phytophthora ramorum* positive nurseries identified to date in 2017. Two of the positive nurseries were actively under the bi-annual sampling portion of the Federal *P. ramorum* Program when they were found positive during their bi-annual sampling surveys in April and May. Both facilities have restarted the Confirmed Nursery Protocol (CNP) process. Three of the other 15 nurseries are also undergoing the CNP as they have compliance agreements in place for interstate shipping. The remaining 12 facilities are retail nurseries that do not ship out of the quarantined area and are therefore not required to implement the CNP. In all, 122 positive plants were identified, including *Cinnamomum camphora*, *Arctostaphylos glauca*, *Umbellularia californica*, and *Laurus nobilis* as well as *Camellia* and *Rhododendron* species.

MONITORING

Two new *P. ramorum* stream positives have been detected in Humboldt County - Eubank Creek, a tributary of the Mattole River, and Yager Creek, a tributary of the Van Duzen River, near the town of Carlotta along Highway 36. Symptomatic California bay laurel samples were collected along Eubank Creek in an effort to locate a potential terrestrial spore source; however, all samples (collected from above and below the stream monitoring site) were negative for the pathogen. As the entirety of Eubank Creek is privately owned, future monitoring activities are uncertain. Google Earth imagery searches were conducted along Yager Creek and Lawrence Creek (a Yager Creek tributary), as most properties adjacent to the creeks are in private ownership. No signs of tree mortality were visible (from Google Earth) except in the previously positive upper part of the North Fork Yager Creek drainage, where *P. ramorum*-positive California bay laurel and tanoak have been confirmed in the Ellison Creek drainage (a North Fork Yager Creek tributary) on private ranchland, approximately 26 creek miles (13 air miles) from the Yager Creek confirmation.

Oregon has had 28 new *P. ramorum* infestations detected to date in 2017 that were at or beyond the Generally Infested Area (GIA) boundary, but well within the 2015 established quarantine area (see map below). The Chetco Bar Fire has burned through 22 infestation sites that were detected within the last 3 years, many of which had already been treated for the pathogen. The current fire suppression strategy is focused on establishing fire lanes in SOD treatment areas, while also keeping the fire away from the western edge of the GIA where there is up to 100% mortality in some tanoak stands. Pathologists from the Oregon Department of Forestry (ODF), US Forest Service, and Oregon State University plan to study the fire's impacts on the pathogen. SOD sanitation stations for fire equipment and personnel have been set up near the GIA boundary and near known SOD infestations. An increased emphasis on disease control during fire suppression/rehabilitation activities (equipment washing, etc.) is planned for the onset of the rainy season. ODF is also in the process of surveying and delimiting new EU1 infestations, which will be the top treatment priorities for the fall.



Curry County, Oregon *P. ramorum* infestations detected to date in 2017.

Nine eastern states are participating in the 2017 National *P. ramorum* Early Detection Survey of Forests (AL, FL, GA, MS, NC, PA, SC, TN, and TX). Of the 385 samples collected

from 57 sites this spring, one sample from AL (first detection in 2008), two samples from one location in MS (first detection in 2008), and two samples from one location in NC (first detection in 2010) have been *P. ramorum* positive. The positive samples were all collected from streams associated with previously positive nurseries.

FUNDING

The Oregon Department of Forestry (ODF) received $450,000 for EU1 *P. ramorum* lineage eradication treatments through the state's biannual budget process. ODF SOD program funding was also restored, bringing the total to combat the pathogen in Oregon to approximately $715,000 over the next 2 years.

RESEARCH

Barnes, C.; Balzter, H.; Barrett, K.; Eddy, J.; Milner, S.; and Suárez, J.C. 2017. Airborne Laser Scanning and Tree Crown Fragmentation Metrics for the Assessment of *Phytophthora ramorum* Infected Larch Forest Stands. Forest Ecology and Management. 404: 294-305.

Abstract: The invasive phytopathogen *Phytophthora ramorum* has caused extensive infection of larch forest across areas of the UK, particularly in Southwest England, South Wales and Southwest Scotland. At present, landscape level assessment of the disease in these areas is conducted manually by tree health surveyors during helicopter surveys. Airborne laser scanning (ALS), also known as LiDAR, has previously been applied to the segmentation of larch tree crowns infected by *P. ramorum* infection and the detection of insect pests in coniferous tree species. This study evaluates metrics from high-density discrete ALS point clouds (24 points/m^2) and canopy height models (CHMs) to identify individual trees infected with *P. ramorum* and to discriminate between four disease severity categories (NI: not infected, 1: light, 2: moderate, 3: heavy). The metrics derived from ALS point clouds include canopy cover, skewness, and bicentiles (B60, B70, B80 and B90) calculated using both a static (1 m) and a variable (50% of tree height) cut-off height. Significant differences are found between all disease severity categories, except in the case of healthy individuals (NI) and those in the early stages of infection (category 1). In addition, fragmentation metrics are shown to identify the increased patchiness and intra-crown height irregularities of CHMs associated with individual trees subject to heavy infection (category 3) of *P. ramorum*. Classifications using a k-nearest neighbour (k-NN) classifier and ALS point cloud metrics to classify disease presence/absence and severity yielded overall accuracies of 72% and 65% respectively. The results indicate that ALS can be used to identify individual tree crowns subject to moderate and heavy *P. ramorum* infection in larch forests. This information demonstrates the potential applications of ALS for the development of a targeted phytosanitary approach for the management of *P. ramorum*.

Cappellazzi, J. and Morrell, J.J., 2017. Potential for Using Borates to Mitigate the Risk of *P. ramorum* Spread on Douglas-fir Logs. Forest Products Journal. *In press*.

Abstract: *Phytophthora ramorum* is an increasingly important tree pathogen in Northern California and Southern Oregon. While it has the greatest effect on tanoak, it can infect a wide range of tree species including Douglas-fir. Oregon has instituted a quarantine area to slow the spread of this pathogen and there are concerns that further restrictions may be imposed on log movement, including those of Douglas-fir. The potential for using boron as log treatment to limit

P. ramorum was evaluated. While boron either alone or in a glycol solution was capable of moving into the bark, there was no evidence that it could move further into the sapwood. The results suggest bark removal would be necessary for use of boron as a mitigation agent for spread of *P. ramorum*.

Kozanitas, M.; Osmundson, T.; Linzer, R.; and Garbelotto, M. 2017. Interspecific Interactions between the Sudden Oak Death Pathogen *Phytophthora ramorum* and Two Sympatric *Phytophthora* Species in Varying Ecological Conditions. Fungal Ecology. 28: 86-96.

Abstract: Even when introduced invasive pathogens lack their natural predators or competitors, they must still interact with other organisms in their introduced range. Sudden Oak Death (SOD), caused by *Phytophthora ramorum* (Oomycota), is an introduced disease causing large-scale tree mortality. Two additional *Phytophthora* species, *Phytophthora nemorosa* and Phy*tophthora pseudosyringae*, cause significantly lower oak mortality, yet they also commonly colonize leaves of *Umbellularia californica*, the major transmissive host of SOD in California. We combined field surveys and inoculation experiments to understand disease prevalence dynamics and competitive interactions among these pathogen species. Despite the broader geographic distribution of *P. nemorosa* with respect to that of *P. ramorum*, our results suggest that *P. nemorosa* exhibits a narrower ecological amplitude and, in any given region, occupies fewer sites than *P. ramorum*. Our results additionally suggest that, perhaps due to priority effects, *P. nemorosa* can persist at levels comparable to those of *P. ramorum* in ecologically suitable plots when climate favors *P. ramorum* dormancy. However, *P. ramorum* prevalence increases to levels higher than those of the competing species when abundant rainfall triggers its sporulation. Understanding the determinants and outcomes of competition between these species has important implications for understanding the epidemiology and possible control strategies for Sudden Oak Death.

Lione, G.; Gonthier, P.; and Garbelotto, M. 2017. Environmental Factors Driving the Recovery of Bay Laurels from *Phytophthora ramorum* Infections: An Application of Numerical Ecology to Citizen Science. Forests. 8(8): 293.

Abstract: *Phytophthora ramorum* is an alien and invasive plant pathogen threatening forest ecosystems in Western North America, where it can cause both lethal and non-lethal diseases. While the mechanisms underlying the establishment and spread of *P. ramorum* have been elucidated, this is the first attempt to investigate the environmental factors driving the recovery of bay laurel, the main transmissive host of the pathogen. Based on a large dataset gathered from a citizen science program, an algorithm was designed, tested, and run to detect and geolocate recovered trees. Approximately 32% of infected bay laurels recovered in the time period between 2005 and 2015. Monte Carlo simulations pointed out the robustness of such estimates, and the algorithm achieved an 85% average rate of correct classification. The association between recovery and climatic, topographic, and ecological factors was assessed through a numerical ecology approach mostly based on binary logistic regressions. Significant ($p < 0.05$) coefficients and the information criteria of the models showed that the probability of bay laurel recovery increases in association with high temperatures and low precipitation levels, mostly in flat areas. Results suggest that aridity might be a key driver boosting the recovery of bay laurels from *P. ramorum* infections.

Morgan, L.A. 2017. Modeling the Spread of Sudden Oak Death across a Heterogeneous Landscape in Redwood National Park Using a Spatially-Explicit Epidemiological Model (Master Thesis). Retrieved from http://digitalcommons.humboldt.edu/cgi/viewcontent.cgi?article=1029&context=etd.

Abstract: The pathogen *Phytophthora ramorum*, the causal agent of Sudden Oak Death (SOD), is responsible for the deaths of millions of oak (*Quercus* spp.) and tanoak (*Notholithocarpus densiflorus*) trees in California and Oregon (USA). A recent infection in Redwood National Park (RNP) in California (USA) provided an opportunity to adapt an existing SOD model to assess the efficacy of current and proposed management strategies. A common method of SOD treatment includes killing both infected and uninfected hosts in the area of infection, as well as the area surrounding the infection to create buffers to account for undetected or cryptic infections. I used the existing SOD model for a larger spatial area (380 ha) and included host density data. Using this model, I show that buffers of plausible width are not effective methods for managing SOD infections in RNP because they do not control spread of the pathogen. Additionally, I ran each model with two dispersal kernels (exponential and power-law) with equal mean spread distances and showed that the shape of the distribution kernel used can significantly alter the outcome of the model. For example, models using 300 m and 400 m buffers with an exponential dispersal kernel predicted containment of *P. ramorum*, but spread beyond these buffers was predicted with a power-law distribution kernel. Lastly, my work provides the first evidence of significant stream-to-land spread of *P. ramorum*. I show laboratory-confirmed *P. ramorum* infections along a creek in RNP, which included low-hanging branches with cankers on host trees concealed by debris. I also used the adapted SOD model to compare two scenarios, one including and one excluding stream-to-land transmission, and found that the model that included stream transmission predicted future spread significantly better than the model that did not include stream transmission. This work not only highlights the problems associated with treating SOD infections by removing hosts in buffer zones surrounding infections, but also demonstrates how precise knowledge about the dispersal distance and dispersal frequency is required to derive accurate model predictions. Additionally, my work points to a novel transmission pathway for an important forest pathogen and highlights the need to determine the prevalence of this dispersal mechanism across the range of the pathogen.

Oszako, T.; Olchowik, J.; Szaniawski, A.; Drozdowski, S.; and Aleksandrowicz-Trzcińska, M. 2017. Emerging Forest Disease in Europe and North America. Folia Forestalia Polonica, series A – Forestry, 59(2): 159-162.

[A short summary is provided about the formation of IUFRO group "7.03.12 – Alien Invasive Species and International Trade" and the IUFRO conference: Working Party 7.02.02 'Invasive Forest Pathogens & Implication for Biology & Policy,' held in Niagara Falls, Canada, May 6 to 13, 2017.]

Globalization and increase of International Trade (larger cargo and faster ships) cause more and more problems in contemporary plant protection in agriculture, horticulture and forestry sectors. The elaborated EU quarantine rules, sufficient in the past, have stopped working in the new circumstances. It is especially frustrating to foresters whose forests are in danger. The main pathway is the soil attached to plant roots of seedlings and asymptomatic plants for plantings.

Some other wood goods like wood fire also need regulation. There is hope that the quickly developing molecular tools allow to detect and identify species in environmental samples (soil, water and plant tissue) on time (Nevoigt et al. 2010; Nowakowska et al. 2016). The pathway oriented legislation seems to be the most efficient way to mitigate this situation. The new IUFRO group "7.03.12 – Alien Invasive Species and International Trade was created to deal with this topic. There are many examples of severe losses in Europe and North America due to the emerging diseases like ash dieback caused by the alien fungus *Hymenoscyphus fraxineus* and *Agrillus plannipenis*, Sudden Oak Death and Japanese larch – *Phytophthora ramorum*, alder decline – *P. alni*, European oak decline phenomenon – complex disease with significant contribution of Phytophthoras, mainly *P. quercina*. Interactions between health status and genetic variability were often sought by scientists (Nowakowska and Oszako 2008). It seems that research on resistance/tolerance of forest tree species to these new threats are urgently needed.

Conference proceedings of the 8th Meeting of the International Union of Forest Research Organizations (IUFRO) Working Party S07-02-09 meeting on *Phytophthora* in Forests and Natural Ecosystems in Hanoi-Sapa, Vietnam, March 18-25, 2017, are now available online at http://forestphytophthoras.org/proceedings.

The following three abstracts on *P. ramorum* were presented at the 2017 APS Annual Meeting, "Changing Landscapes of Plant Pathology," in San Antonio, TX, August 5th – 9th. https://www.apsnet.org/meetings/annual/abstracts/Pages/default.aspx.

Goss, E.M. and Wang, J. 2017. Pathways and Populations in Phytophthora: A Legacy of Destruction. 34-S.

Mavrodieva, V.A.; Dennis, G.; and Shiel, P.J. 2017 USDA APHIS NPPLAP Proficiency Testing and Planned Methods Deviation as a Part of the Methods' Validation Process for a Network of Laboratories. 27-S.

Pokharel, R.R. 2017. Incidence of *Phytophthora* in Maryland Nurseries. 451-P.

RELATED RESEARCH

Ávila Méndez, Kelly and Romero, Hernán Mauricio. 2017. Plant Responses to Pathogen Attack: Molecular Basis of Qualitative Resistance. Revista Facultad Nacional de Agronomía - Medellín. 70: 8225-8235.

Bonants P. and te Witt R. 2017. Molecular Diagnostics in Plant Health. In: van Pelt- Verkuil E., van Leeuwen W., te Witt R. (eds) Molecular Diagnostics. Springer, Singapore.

Flory, S.L.; Alba, C.; Clay, K.; Holt, R.D.; and Goss, E.M. 2017. Emerging Pathogens Can Suppress Invaders and Promote Native Species Recovery. Biological Invasions. pp.1-4.

Grünwald, N.J.; Everhart, S.E.; Knaus, B.J.; and Kamvar, Z.N. 2017. Best Practices for Population Genetic Analyses. Phytopathology. 107(9): 1000-1010.

Holmes, T.P.; Allen, W.; Haight, R.G.; Keskitalo, E.C.H.; Marzano, M.; Pettersson, M.; Quine, C.P.; and Langer, E.L. 2017. Fundamental Economic Irreversibilities Influence Policies for Enhancing International Forest Phytosanitary Security. Current Forestry Reports. pp.1-11.

Jung, T.; Scanu, B.; Bakonyi, J.; Seress, D.; Kovács, G.M.; Durán, A.; Sanfuentes von Stowasser, E.; Schena, L.; Mosca, S.; Thu, P.Q.; Nguyen, C.M.; Fajardo, S.; González, M.; Pérez-Sierra, A.; Rees, H.; Cravador, A.; Maia, C.; and Horta Jung, M. 2017. *Nothophytophthora* gen. nov., a New Sister Genus of *Phytophthora* from Natural and Semi-Natural Ecosystem. Persoonia-Molecular Phylogeny and Evolution of Fungi. https://doi.org/10.3767/persoonia.2017.39.07.

Marzano, M.; Allen, W.; Haight, R.G.; Holmes, T.P.; Keskitalo, E.C.H.; Langer, E.L.; Shadbolt, M.; Urquhart, J.; and Dandy, N. 2017. The Role of the Social Sciences and Economics in Understanding and Informing Tree Biosecurity Policy and Planning: A Global Summary and Synthesis. Biological Invasions. pp.1-16.

Shelley, B.A.; Luster, D.G.; Garrett, W.M.; McMahon, M.B.; and Widmer, T.L. 2017. Temperature Effects on *Phytophthora kernoviae* Germination of Sporangia, Infection, and Protein Secretion. Plant Pathology. DOI: 10.1111/ppa.12782.

Sniezko, R.A. and Koch, J. 2017. Breeding Trees Resistant to Insects and Diseases: Putting Theory into Application. Biological Invasions. pp.1-24. DOI: 10.1007/s10530-017-1482-5.

Woodcock, P.; Cottrell, J.E.; Buggs, R.J.; and Quine, C.P. 2017. Mitigating Pest and Pathogen Impacts Using Resistant Trees: A Framework and Overview to Inform Development and Deployment in Europe and North America. Forestry: An International Journal of Forest Research. pp.1-16.

The following abstract on Phytophthoras was presented by National Ornamentals Research Site at Dominican University of California at the 2017 APS Annual Meeting, "Changing Landscapes of Plant Pathology," in San Antonio, TX, August 5th – 9th. https://www.apsnet.org/meetings/annual/abstracts/Pages/default.aspx.

Miles, T.; Schweigkofler, W.; Sharma, S.; Luecke, N.; Kosta, K.L.; and Suslow, K.G. 2017. Assessing the Potential for Phytophthora to Move between Native Plant Nurseries and Interstate Shipping Nurseries. 446-P.

EDUCATION AND OUTREACH

Four SOD Blitz Workshops will be offered this fall to discuss the results of the 2017 SOD Blitz spring surveys as well as new recommendations for protecting oak trees. Workshops are intended for the general public, tree care professionals, and land managers. This program has been reviewed and is approved for professional CFE credits by the Society of American Foresters (Category 1-CF: 2). For more information, see the Calendar of Events below.

You may have noticed the updated, streamlined COMTF website. Over the past months, a small team has been working to tidy it up so information is more concise and easier to find from

your desktop computer and your mobile device. We invite you to click around and rediscover what the site has to offer!

RESOURCES

The Oregon Sudden Oak Death Task Force Strategic Action Plan has been finalized and is available online at http://bit.ly/sod2017-strategicplan. Areas of focus include scientific research, SOD treatment, all lands coordination, adaptation within the quarantine area, communications and civic engagement, economic impact, workforce development, and funding. Plan implementation is underway.

PERSONNEL

The COMTF Outreach Coordinator, Janice Alexander, bids a fond farewell to the world of SOD as she moves with her family to Boise, Idaho. Janice has been with UC Cooperative Extension and the COMTF since 2002. Starting in September 2017, she will be the Discovery Center of Idaho Education Manager. Please contact Katie Harrell in lieu of Janice for all COMTF outreach-related inquiries at kpalmieri@berkeley.edu or (510) 847-5482.

Richard Cobb has accepted a position at Cal Poly as an Assistant Professor of Forest Health. This position was previously held by Wally Mark (former COMTF Monitoring Committee Co-Chair). In his new role, Richard will teach forest health education on insects and pathogens in the Department of Natural Resources and Environmental Science. Previously Richard worked in the UC Davis Rizzo lab on SOD-related research - four years as a PhD student, five as a post-doc, and two as an Assistant Project Scientist. Richard will continue to work on SOD research and management, with a greater emphasis on the Big Sur region and *P. ramorum* invasion of new habitats and counties. Richard can be reached at rccobb@calpoly.edu or (805) 756-6333.

CALENDAR OF EVENTS

10/13/17 Sudden Oak Death SOD Blitz Fall Workshop; Portola Valley Town Center; 765 Portola Rd, Portola Valley; 7:00 – 9:00 p.m.

10/20/17 Sudden Oak Death SOD Blitz Fall Workshop; UC Cooperative Extension Office; 133 Aviation Blvd., Santa Rosa; 7:00 – 9:00 p.m.

10/25/17 Sudden Oak Death SOD Blitz Fall Workshop; 251 C Hilgard Hall, UC Berkeley Campus, Berkeley; 1:00 – 3:00 p.m.; To register, email Katie Harrell with your name, phone number, and your affiliation (homeowner, professional, other).

11/8/17 Sudden Oak Death SOD Blitz Fall Workshop; 251 C Hilgard Hall, UC Berkeley Campus, Berkeley; 1:00 – 3:00 p.m.; To register, email Katie Harrell with your name, phone number, and your affiliation (homeowner, professional, other).

11/15 – 11/16 – 66th Annual Meeting of the California Forest Pest Council, "Responding to Large-Scale Tree Mortality in Urban and Rural Communities;" UC Davis Campus Student Community Center Multipurpose Room, Davis; For more information, or to register, go to http://caforestpestcouncil.org/2017/04/save-the-date-cfpc-annual-meeting-nov-15-16-2017/.

2/1 – 2/3/18 – 2018 California Native Plant Society Conservation Conference; Los Angeles Airport Marriott; 5855 West Century Boulevard, Los Angeles; For more information, go to https://conference.cnps.org/.