CALIFORNIA OAK MORTALITY TASK FORCE REPORT
MAY 2017

MONITORING

***Phytophthora ramorum* confirmed 3 miles from currently uninfested Hoopa Valley tribal** lands - Tanoak and CA bay laurel trees have been found *P. ramorum* positive on Bureau of Land Management property along Lacks Creek (near King's Crossing), adjacent to the Redwood Valley infestation (found positive in 2011) and approximately 3 miles from the western boundary of the Hoopa Valley Reservation.

Bleeding tanoak at Lacks Creek. Photo: D. Stark, UCCE Humboldt Co.

Seasonal stream near infected bay and tanoak. Photo: D. Stark, UCCE Humboldt Co.

P. ramorum was found in Lacks Creek in 2016 during early detection stream monitoring surveys. Follow-up Google Earth imagery scanning for creek-related mortality revealed a single dead tanoak. Upon field inspection, the mortality was attributed to suppressed growing conditions and Armillaria root disease. However, there were several standing green tanoaks nearby with bole cankers that were close to a seasonal creek. Symptomatic tanoak twigs and leaves were collected from the basal sprouts of bleeding tanoaks as well as other tanoaks in the area and from symptomatic bay sprout clumps, saplings, and trees. Results were positive for *P. ramorum*, primarily from symptomatic tanoak twig samples. Early-stage *P. ramorum* symptoms were noted on bay and tanoak. The BLM is currently evaluating the extent of the infection and exploring management options.

OREGON

Oregon has had 12 new *P. ramorum* infestations detected to date in 2017 that were at or beyond the Generally Infested Area boundary but well within the 2015 established quarantine area (see Figure 1).

In March, the Oregon Sudden Oak Death Task Force convened for the first time, under the leadership of Oregon State Representative David Brock Smith and US Senator Merkley. The Task Force is developing a collaborative action plan to secure adequate funding to contain the Oregon NA1 infestations and eradicate the EU1 lineage. Subcommittees have been formed to address a comprehensive disease management program, identify research needs, develop a framework for living with the disease, integrate an all-lands approach, develop an updated economic impact assessment, and formulate an education and outreach strategy.

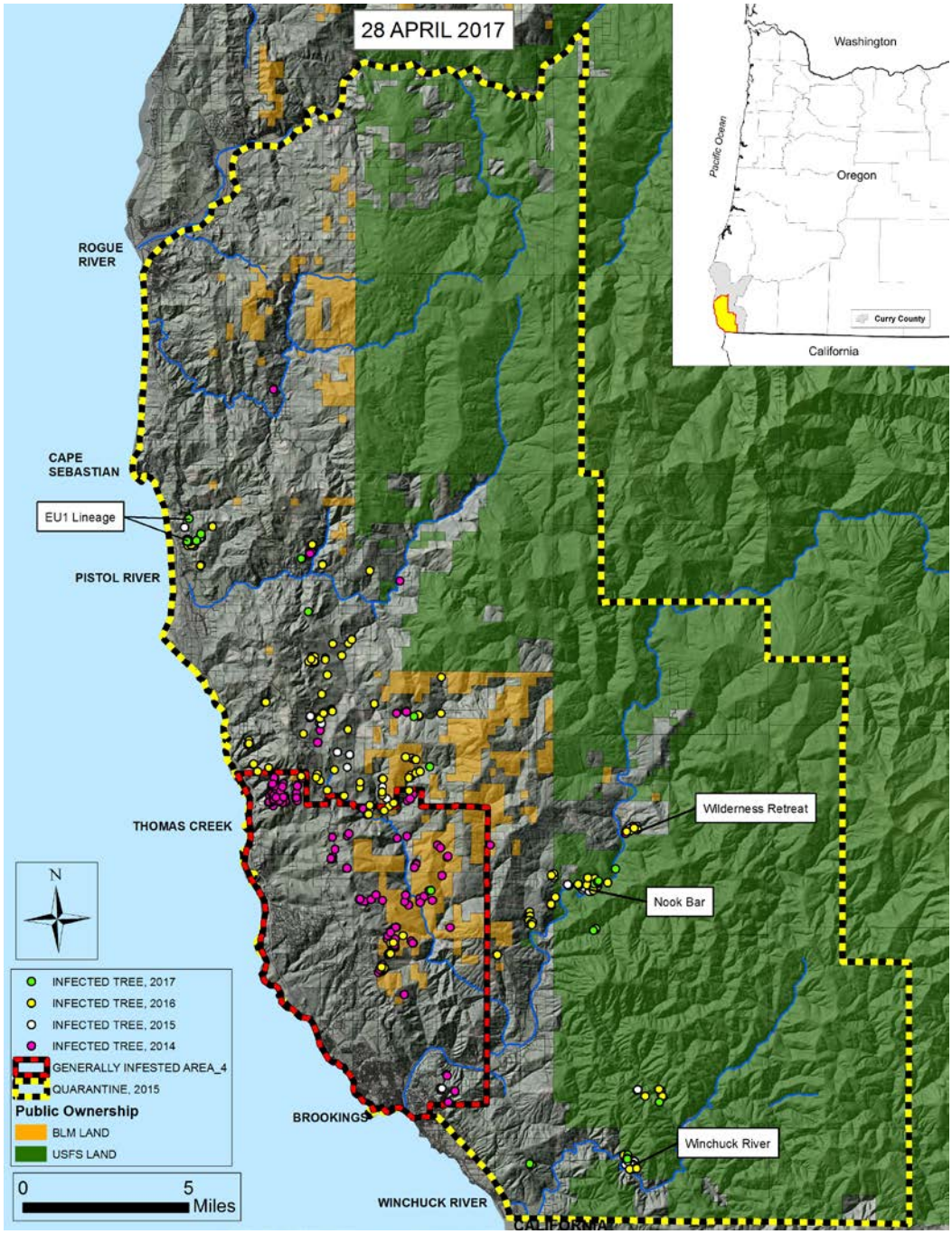

Figure 1. Oregon map of Curry County *P. ramorum* infestation.

NURSERIES

Two California nurseries were confirmed positive for *P. ramorum* on May 1, 2017. One of the finds was at a Sonoma County retail nursery that was found to have four positive *Camelia spp*. samples during a random county inspection. The Nursery Cleanliness Protocol will be implemented at the facility. The other find was at a Santa Clara County nursery during a spring compliance survey. One positive water sample was recovered from a creek that runs through the property (creek water is not used for watering, but it does receive runoff from watered plants) in addition to one positive soil sample from a recycled pot. The nursery does ship interstate and has

implemented the Confirmed Nursery Protocol for soil and water. Foliar sample results are pending.

In 2016, four previously positive opt-in CA nurseries were released from the federal *P. ramorum* compliance program confirmed nursery protocol (CNP). Before being allowed to resume interstate shipping, the sites had to be negative for *P. ramorum* for 3 consecutive years or 6 bi-annual samplings. Another nursery found to have four positive samples in 2016 is currently undergoing the Confirmed Nursery Protocol and has decided to opt-out of the federal program, relinquishing interstate shipping rights. The remaining 2 nurseries in the compliance program are currently undergoing spring sampling. One of the nurseries is scheduled to be released from the program pending a successful 2017 spring and fall sampling. The other nursery is projected to be released in 2020.

Quarterly surveys of Washington's Kitsap County Botanical Garden (first found *P. ramorum* positive in 2015) are underway. The February 2017 survey was negative for the pathogen. In late April, 274 samples were collected near previous positive locations and around the garden perimeter. Lab results are pending. The next survey is scheduled for September.

A trace-forward investigation is underway for several out-of-state shipments received in nurseries in Thurston, Pierce, and King Counties in December 2016. Results are pending.

The Systems Approach to Nursery Certification (SANC) Program had its first pilot facilities sign agreements with their respective state regulatory agencies in August 2016, allowing them to ship interstate nursery stock certified under the SANC Pilot Program. There are currently eight facilities participating in the SANC Pilot Phase 1, three of which have signed SANC Agreements.

Planning for SANC Pilot Phase II is underway. This phase will address the initial recommendations of the Evaluation Subcommittee to implement SANC at Phase I sister operations and states, verify the scalability of SANC, and review commonalities with the US-Canadian Greenhouse Certification Program. Phase II was initiated in the fall of 2016. SANC has identified 2021 as the target year for full implementation. This project is supported by AmericanHort, USDA APHIS Plant Protection and Quarantine (PPQ), and the National Plant Board (NPB)

RESEARCH

A new *Phytophthora* Research Centre (PRC) has been established at Mendel University in Brno, Czech Republic. The PRC, funded by the Czech government and co-financed by the European Regional Development Fund, employs 15 full-time scientists and is being overseen by Thomas Jung, Head Scientific Researcher, and Libor Jankovski, Administrative Lead. The goal of the center is to develop a deeper understanding of the factors driving diversity, adaptation, and hybridizations within the *Phytophthora* genus; the evolutionary history of the genus *Phytophthora* and the molecular mechanisms behind susceptibility and tolerance in oaks to soilborne *Phytophthora* spp.; and to transfer knowledge gained into management and control strategies for *Phytophthora* diseases in forests and natural ecosystems. For more information see

http://www.czelo.cz/en/other-programmes-and-initiatives/synergies-with-structural-funds/news/phytophthora-research-centre.

Barnes, C.; Balzter, H.; Barrett, K.; Eddy, J.; Milner, S.; and Suárez, J.C. 2017. Individual Tree Crown Delineation from Airborne Laser Scanning for Diseased Larch Forest Stands. Remote Sensing. 9(3): 231. DOI: 10.3390/rs9030231.

Abstract: Airborne laser scanning (ALS) can be utilized to derive canopy height models (CHMs) for individual tree crown (ITC) delineation. In the case of forest areas subject to defoliation and dieback as a result of disease, increased irregularities across the canopy can add complications to the segmentation of ITCs. Research has yet to address this issue in order to suggest appropriate techniques to apply under conditions of forest stands that are infected by phytopathogens. This study aimed to find the best method of ITC delineation for larch canopies affected by defoliation as a result of a *Phytophthora ramorum* infection. Sample plots from two study sites in Wales, United Kingdom, were selected for ITC segmentation assessment across a range of infection levels and stand characteristics. The performance of two segmentation algorithms (marker-controlled watershed and region growing) were tested for a series of CHMs generated by a standard normalized digital surface model and a pit-free algorithm, across a range of spatial resolutions (0.15 m, 0.25 m and 0.5 m). The results show that the application of a pit-free CHM generation method produced improved segmentation accuracies in moderately and heavily infected larch forest, compared to the standard CHM. The success of ITC delineations was also influenced by CHM resolution. Across all plots the CHMs with a 0.25 m pixel size performed consistently well. However, lower and higher CHM resolutions also provided improved delineation accuracies in plots dominated by larger and smaller canopies respectively. The selected segmentation method also influenced the success of ITC delineations, with the marker-controlled watershed algorithm generating significantly more accurate results than the region growing algorithm ($p < 0.10$). The results demonstrate that ITCs in forest stands infected with *Phytophthora ramorum* can be successfully delineated from ALS when a pit-free algorithm is applied to CHM generation.

Cobb, R.C. and Metz, M.R. 2017. Tree Diseases as a Cause and Consequence of Interacting Forest Disturbances. Forests. 8(5): 147. DOI: 10.3390/f8050147. Published as part of a "Forest Pathology and Plant Health" special issue of *Forests.*

Abstract: The disease triangle is a basic and highly flexible tool used extensively in forest pathology. By linking host, pathogen, and environmental factors, the model provides etiological insights into disease emergence. Landscape ecology, as a field, focuses on spatially heterogeneous environments and is most often employed to understand the dynamics of relatively large areas such as those including multiple ecosystems (a landscape) or regions (multiple landscapes). Landscape ecology is increasingly focused on the role of co-occurring, overlapping, or interacting disturbances in shaping spatial heterogeneity as well as understanding how disturbance interactions mediate ecological impacts. Forest diseases can result in severe landscape-level mortality which could influence a range of other landscape-level disturbances including fire, wind impacts, and land use among others. However, apart from a few important exceptions, these disturbance-disease interactions are not well studied. We unite aspects of forest pathology with landscape ecology by applying the disease-triangle approach from the

perspective of a spatially heterogeneous environment. At the landscape-scale, disturbances such as fire, insect outbreak, wind, and other events can be components of the environmental 'arm' of the disease triangle, meaning that a rich base of forest pathology can be leveraged to understand how disturbances are likely to impact diseases. Reciprocal interactions between disease and disturbance are poorly studied but landscape ecology has developed tools that can identify how they affect the dynamics of ecosystems and landscapes.

Frankel, S.J. and Harrell, K.M., tech. coords. 2017. Proceedings of the Sudden Oak Death Sixth Science Symposium. Gen. Tech. Rep. GTR-PSW-255. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 106 p.

The Proceedings of the Sudden Oak Death Sixth Science Symposium (SOD 6) are now online at https://www.fs.fed.us/psw/publications/documents/psw_gtr255/index.shtml. The publication is only available online and contains summaries and papers from talks and posters presented at SOD 6, held June 20 - 23, 2016 in San Francisco, CA. A sudden oak death management focused SOD 6 proceedings volume will be published later this year in the journal *Forest Phytophthoras*.

Gagnon, M.C.; Feau, N.; Dale, A.L.; Dhillon, B.; Hamelin, R.C.; Brasier, C.M.; Grünwald, N.J.; Brière, S.C.; and Bilodeau, G.J. 2017. Development and Validation of Polymorphic Microsatellite Loci for the NA2 Lineage of *Phytophthora ramorum* from Whole Genome Sequence Data. Plant Disease. 101(5): 666-673.

Abstract: *Phytophthora ramorum* is the causal agent of sudden oak death and sudden larch death, and is also responsible for causing ramorum blight on woody ornamental plants. Many microsatellite markers are available to characterize the genetic diversity and population structure of *P. ramorum*. However, only two markers are polymorphic in the NA2 lineage, which is predominant in Canadian nurseries. Microsatellite motifs were mined from whole-genome sequence data of six *P. ramorum* NA2 isolates. Of the 43 microsatellite primer pairs selected, 13 loci displayed different allele sizes among the four *P. ramorum* lineages, 10 loci displayed intralineage variation in the EU1, EU2, and/or NA1 lineages, and 12 microsatellites displayed polymorphism in the NA2 lineage. Genotyping of 272 *P. ramorum* NA2 isolates collected in nurseries in British Columbia, Canada, from 2004 to 2013 revealed 12 multilocus genotypes (MLGs). One MLG was dominant when examined over time and across sampling locations, and only a few mutations separated the 12 MLGs. The NA2 population observed in Canadian nurseries also showed no signs of sexual recombination, similar to what has been observed in previous studies. The markers developed in this study can be used to assess *P. ramorum* inter- and intralineage genetic diversity and generate a better understanding of the population structure and migration patterns of this important plant pathogen, especially for the lesser-characterized NA2 lineage.

Pastalka, T.; Rooney-Latham, S.; Kosta, K.; Suslow, K.; Huffman, V.; Ghosh, S.; and Schweigkofler, W. 2017. Monitoring Using a Sentinel Plant System Reveals Very Limited Aerial Spread of *Phytophthora ramorum* from Infected Ornamental Plants in a Quarantine Research Nursery. Plant Health Progress. 18: 9 – 16. DOI: 10.1094/PHP-RS-16-0050.

Abstract: The potential aerial spread of *Phytophthora ramorum*, causal agent of sudden oak death and ramorum blight, from infected plants in a quarantine research nursery at the National Ornamentals Research Site at Dominican University of California (NORS-DUC) to the environment was monitored weekly for five years (2011 to 2016) using a sentinel system. *Phytophthora ramorum* was never detected on any of the sentinel plants (*Rhododendron*, *Viburnum*, and *Loropetalum* spp.), indicating very limited aerial spread under suboptimal meteorological and environmental conditions. An infection experiment with host plants placed in the immediate vicinity of symptomatic plants proved the potential for short-distance (1 to 2 m) aerial transmission of *P. ramorum*. Other *Phytophthora* spp. causing symptoms similar to *P. ramorum* were detected during the rainy season (January to May) on the sentinel plants, among them potentially two novel species. These data reveal how sentinel monitoring at NORS-DUC allows for seasonal assessments of disease incidence and provide longitudinal data to assess the threat of *P. ramorum* movement in nurseries.

Tonini, F.; Shoemaker, D.; Petrasova, A.; Harmon, B.; Petras, V.; Cobb R.C.; Mitasova, H.; and Meentemeyer, R.K. 2017. Tangible Geospatial Modeling for Collaborative Solutions to Invasive Species Management. Environmental Modelling & Software. 92: 176–188.

Abstract: Managing landscape-scale environmental problems, such as biological invasions, can be facilitated by integrating realistic geospatial models with user-friendly interfaces that stakeholders can use to make critical management decisions. However, gaps between scientific theory and application have typically limited opportunities for model-based knowledge to reach the stakeholders responsible for problem-solving. To address this challenge, we introduce Tangible Landscape, an open-source participatory modeling tool providing an interactive, shared arena for consensus-building and development of collaborative solutions for landscape-scale problems. Using Tangible Landscape, stakeholders gather around a geographically realistic 3D visualization and explore management scenarios with instant feedback; users direct model simulations with intuitive tangible gestures and compare alternative strategies with an output dashboard. We applied Tangible Landscape to the complex problem of managing the emerging infectious disease, sudden oak death, in California and explored its potential to generate co-learning and collaborative management strategies among actors representing stakeholders with competing management aims.

Varner, J.M.; Kuljian, H.G.; and Kreye, J.K. 2017. Fires without Tanoak: The Effects of a Non-Native Disease on Future Community Flammability. Biological Invasions. DOI: 10.1007/s10530-017-1443-z.

Abstract: Non-native pathogens affect forests throughout North America, resulting in changes in species composition, structure, and ecosystem processes. We studied the effects of the emergent disease sudden oak death (SOD) and the resulting functional extinction of tanoak, a highly susceptible native tree with flammable litter, on future community flammability. We quantified four flammability metrics (flame height; flaming duration; smoldering duration; and fuel consumed) for litter from each of five species that co-occur with tanoak and for species mixtures with and without tanoak (n = 14). We combined these flammability metrics in a Principal Components Analysis to evaluate potential shifts in litter flammability from pre-SOD (with tanoak litter) to post-SOD (where tanoak was replaced equally with remaining species). Litter

flammability changed following the loss of tanoak, but the differences were species- and community-specific. Mixed-evergreen fuels where coast Douglas-fir litter replaced tanoak experienced consistent declines in flammability. Few substantive changes occurred in communities where coast redwood or other hardwoods co-occurred. We found consistent synergistic flammability effects when multiple species' litters were mixed; in cases where two or more species were mixed, most (75%) combinations burned with higher intensity (+8.1%) and fuelbeds flamed for a longer duration (+17.1%). Our work demonstrates that potential surface fire behavior in northwestern California may be dampened where Douglas-fir replaces tanoak, while those communities with other hardwoods or coast redwood may have redundant fuels and tanoak's absence in future fires may be inconspicuous. These results underscore the potential for cascading effects of non-native pathogens on ecosystem function in fire-prone ecosystems.

RELATED RESEARCH

Davies, S.; Patenaude, G.; and Snowdon, P. 2017. A New Approach to Assessing the Risk to Woodland from Pest and Diseases. Forestry. DOI: 10.1093/forestry/cpx001.

González, M.; Caetano, P.; and Sánchez, M.E. 2017. Testing Systemic Fungicides for Control of *Phytophthora* Oak Root Disease. Forest Pathology. DOI: 10.1111/efp.12343.

Gullino, M.L.; Stack, J.P.; Fletcher, J.; and Mumford, J.D., editors. 2017. Practical Tools for Plant and Food Biosecurity. Results from a European Network of Excellence. Vol. 8. Springer International Publishing. DOI: 10.1007/978-3-319-46897-6.

Hyatt-Twynam, S. R., Parnell, S., Stutt, R.O.J.H.; Gottwald, T.R.; Gilligan, C.A.; and Cunniffe, N.J. 2017. Risk-Based Management of Invading Plant Disease. New Phytologist. 214: 1317–1329. DOI: 10.1111/nph.14488.

Le, D.T. and Vu, N.T. 2017. Progress of Loop-Mediated Isothermal Amplification Technique in Molecular Diagnosis of Plant Diseases. Applied Biological Chemistry. 60: 169. DOI:10.1007/s13765-017-0267-y.

OUTREACH AND EDUCATION

Spring SOD Blitzes are underway. Community members living near areas known to be impacted by SOD are encouraged to attend a Blitz and learn how to look for the disease so that they can monitor for it in their community, facilitating early detection of new outbreaks. As symptomatic California bay laurel leaves and tanoak leaves and twigs generally precede oak infections, and are often the first sign that *P. ramorum* is in a location, participants will be trained to identify and collect symptomatic bay and tanoak samples as well as how to record sample locations. Those that have attended a training before should still attend one this year to receive necessary supplies. Blitz participants are encouraged to bring their iPhone or Android smartphone to the training session so they can learn how to use their mobile device as a GPS to mark sample locations using the free SODMAP app. Samples will be taken to the Garbelotto lab at UC Berkeley to determine the presence or absence of the pathogen. Results will be published in the fall at www.sodblitz.org. For details on Blitz locations and information, see the "Calendar of Events" below.

Washington State University and Oregon State University held two half-day workshops on "Preventing *Phytophthora* Contamination in Native Plant Nurseries and Restoration Sites" this spring. The workshops were prompted by the *Phytophthora* detections in California native plant nurseries and habitat restoration sites. Those findings spurred follow-up investigations that indicate a similarly high infestation rate in Oregon and Washington native plant nurseries. The sessions for Washington and Oregon native plant nursery growers covered how to identify symptoms and best management practices needed to minimize risk of *Phytophthora* introduction, establishment, and spread. For more on information offered at the workshops, contact Marianne Elliott at melliott2@wsu.edu or Jennifer Parke at Jennifer.Parke@oregonstate.edu.

NORS-DUC CORNER

The USDA Agricultural Research Service, Foreign Disease-Weed Science Research Unit is collaborating with NORS-DUC to develop rapid immunoassays for *P. ramorum* in nursery water samples. Currently, detection of *P. ramorum* in water typically requires baiting followed by pathogen growth and/or expensive molecular detection methods.

The project, led by Doug Luster, USDA, will develop rapid antibody detection tools for *P. ramorum* in nurseries, focusing on irrigation sources and runoff as well as surface water. The four research objectives include: developing methods for concentrating and capturing *P. ramorum* propagules in water samples; generating monoclonal antibodies (MAbs) that are reactive to infectious *P. ramorum* propagules (sporangia, zoospores); testing antibodies in ELISA and developing detection assays from nursery irrigation water, surface water, and irrigation samples from the NORS-DUC mock nursery; and transferring MAbs and associated technology to the USDA Animal and Plant Health Inspection Service Plant Protection and Quarantine, commercial diagnostic companies, and diagnostic laboratories. A rapid, inexpensive detection tool would greatly reduce the time, cost, and effort needed to demonstrate that nurseries are free from *P. ramorum*. The goals of the project are to help growers detect and more effectively manage *P. ramorum*, eliminate pathogen spread, and minimize the potential for economic losses through crop destruction.

PERSONNEL

Carolyn Lambert replaced Lindsay Rains as a contact for the CA Department of Food and Agriculture (CDFA) *P. ramorum* nursery program. Carolyn can be reached at (916) 403-6804 or carolyn.lambert@cdfa.ca.gov. Terra Walber is another contact for the CDFA *P. ramorum* program and can be reached at (916) 403-6712 or terra.walber@cdfa.ca.gov.

Betsy Randall-Schadel has replaced Stacy Scott as the *P. ramorum* National Operations Manager (NOM) for USDA APHIS PPQ. In this role, she works closely with states to coordinate *P. ramorum* regulatory activities, surveys, and pest management activities, including site detections, traces, and follow-up inspections. She also coordinates eradication and emergency response efforts. Betsy also monitors compliance agreements and manages data generated through surveys, inspections, and compliance programs. Betsy is also the NOM for PPQ's Federally Recognized State Managed Programs. She began these duties in January 2017 and is stationed in Raleigh, North Carolina. Betsy can be reached at Betsy.Randall-Schadel@aphis.usda.gov or 919-855-7544.

CALENDAR

5/11 – San Luis Obispo SOD Blitz; San Luis Obispo County Extension Office, Conference Room; 2156 Sierra Way, San Luis Obispo; 1:00 – 2:00 pm. For more information, contact Kim Corella at Kim.Corella@fire.ca.gov.

5/12 – Atascadero SOD Blitz; Atascadero Library, Martin Polin Room; 6555 Capistrano Ave, Atascadero; 6:00 – 7:00 pm. For more information, contact Lauren Brown at lbrown805@charter.net.

5/13 – Karuk SOD Blitz; Karuk Department of Natural Resources; 39051 HWY 96, Orleans; 10:00 – 11:00 am. For more information, contact Heather Rickard at hrickard@karuk.us.

5/27 – Los Gatos Mountains SOD Blitz; Christ Child Church; 23230 Summit Rd, Los Gatos; 10:00 – 11:00 am. For more information, contact Peter Guilhamet at peterguilhametjr@gmail.com.

5/31 – Petaluma SOD Blitz; Petaluma Community Center; 320 N McDowell Blvd, Petaluma**;** 5:00 – 6:00 pm. For more information, contact Kerry Wininger at kerrywininger@gmail.com.

6/3 – Sonoma County SOD Blitzes; 9:00 – 10:00 am; 4 locations. For more information, contact Kerry Wininger at kerrywininger@gmail.com.

- Spring Lake Park Environmental Discovery Center; 393 Violetti Drive, Santa Rosa. Use park entrance at Violetti Drive, upper parking lot.
- Graton Community Club; 8996 Graton Rd, Graton
- Sonoma Community Center; 276 E Napa St, Sonoma
- Galbreath Wildlands Preserve; meet at the Yorkville Post Office; 25400 CA-128, Yorkville; A 4-wheel drive vehicle is required or park at the post office and passenger in a Sonoma State University vehicle. Advanced RSVP is appreciated.

6/3 – Mendocino SOD Blitz; Albion School; 30400 Albion Ridge Rd, Albion; 10:00 – 11:00 am. For more information, contact Mario Abreu at abreu@mcn.org.