SUDDEN OAK DEATH/*PHYTOPHTHORA RAMORUM* STATUS IN CALIFORNIA URBAN AND WILDLAND FORESTS

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Sudden Oak Death Tree Mortality and Infestation Status

Sudden oak death (SOD, caused by *Phytophthora ramorum*) continues to be the primary cause of tree mortality in coastal California from Monterey Co. north to Humboldt Co., according to USDA FS Pacific Southwest Region, Forest Health Protection 2013 aerial survey. Tanoak mortality is severe in the Santa Cruz Mountains as well as along the coast in Sonoma, Marin and Monterey Cos., with the most severely impacted areas in Jenner and Guerneville (Sonoma Co.) as well as Big Sur and Mill Creek (Monterey Co.). In coastal Mendocino Co.; new pockets of tanoak mortality were seen in and near Fort Bragg. Intense coast live oak mortality was mapped in the Oakland hills (Alameda Co.) and east of Watsonville (Santa Cruz Co.), about 9 miles from the closest SOD confirmation. Similar to past years, no tanoak mortality was observed in Del Norte Co. The total number of acres with recent mortality and number of trees killed due to SOD in California is slightly lower than last year's levels, with over 294,000 dead trees on 47,500 acres. California's 2012 SOD mortality levels were the highest since 2007, and elevated mortality levels continued into 2013, particularly in cooler coastal areas.

Phytophthora ramorum has been confirmed near the Six Rivers National Forest (SRNF) and the Trinity Co. line, with infected tanoak and California bay laurel less than 1 mile from both the SRNF boundary and Trinity Co. boundary. The pathogen is spreading from the Redway area, further north in the Larabee Creek corridor, and is now approximately 7.5 miles south of the town of Bridgeville (Humboldt Co.).

Other significant new finds include an infestation at Jackson Demonstration State Forest (Mendocino Co.), and at Golden Gate Park (San Francisco Co.) in a nursery adjacent to the AIDS Memorial Grove. The Golden Gate Park discovery was part of the 2013 SOD Blitz survey, with over 400 volunteer surveyors, led by Matteo Garbelotto, UC Berkeley. For more SOD Blitz results, see the UC Berkeley Forest Pathology and Mycology website at http://nature.berkeley.edu/garbelotto/english/index.php.

Stream Monitoring Survey

In 2013, 136 waterway sites distributed throughout Del Norte, Humboldt, Mendocino, Sonoma, Monterey, San Luis Obispo, and San Benito Cos. were monitored for *P. ramorum.* Waterway monitoring is a collaborative effort lead by Heather Mehl out of David Rizzo's laboratory, UC Davis.

In Humboldt Co., *P. ramorum* was detected for the first time in Roaring Gulch, an upper tributary of Redwood Creek located in Redwood Valley. With the exception of a monitoring site

on Redwood Creek, all watersheds monitored in Redwood NP remained negative. All watersheds monitored on Hoopa Valley and Yurok Tribal lands also continued to be *P. ramorum* negative. In the McKinleyville area, two new monitoring sites located upstream of a residential development area tested positive for *P. ramorum*, and in southern Humboldt Co., a new monitoring site along the southwestern border of the SRNF (North Dobbyn Creek) was consistently *P. ramorum* positive.

In Mendocino Co., a new monitoring site on a tributary of the South Fork of the Eel River (Hollow Tree Creek) tested *P. ramorum* positive once in March. The South Fork of the Noyo River (SFNR) watershed in the Jackson Demonstration State Forest (JDSF) was intensively sampled this year to pinpoint the source of inoculum detected in the watershed in 2012. *P. ramorum* was recovered from the North Fork of the SFNR and from a small tributary of the South Fork of the SFNR (Peterson Gulch). The Little North Fork of the Big River (LNFB), sampled in Mendocino Woodlands SP, tested *P. ramorum* positive for the first time in May and June. The LNFB watershed spans both Mendocino Woodlands SP and JDSF lands. Several ground surveys have been conducted in response to this find, but terrestrial infections in this watershed have not been identified.

In Sonoma Co., multiple watersheds in the Kruse Rhododendron State Natural Reserve and Salt Point SP were sampled in response to a terrestrial *P. ramorum* detection in this area in 2012. *P. ramorum* was recovered from all sampled watersheds, indicating extensive pathogen spread along this portion of the Sonoma coast. There were no new positive watersheds in Monterey Co., and all watersheds monitored in San Luis Obispo Co. were *P. ramorum* negative this year. In 2012, *P. ramorum* was detected through PCR-based diagnostics in San Carpoforo Creek, a watershed spanning both Monterey and San Luis Obispo Cos.; however, no samples from this watershed were positive in 2013.

Management

In Humboldt Co., 2013 has been a year of transition for SOD management, with the Redwood Valley eradication effort shifting from direct control (the rapid removal of infected tanoak and bay laurel) to a still evolving strategy of conservation management, where stand species composition is redirected toward conifers, with a goal of tanoak retention at low levels and slowed pathogen spread.

Since 2011, an isolated outbreak (initially detected on privately owned properties in 2010) in Redwood Valley has been under direct control, with 350 acres and a buffer zone treated with herbicide or by removal of infected trees. The multi-agency collaborative effort, led by University of California Cooperative Extension, Humboldt and Del Norte Cos., has relied on early detection and rapid response. Despite treatment, wet springs led to pathogen spread in 2010, 2011, and 2012; consequently, eradication would now require treatment of more than 2,000 additional acres. The infestation spread to steep, rocky, densely vegetated terrain around Lacks Creek, instigating the Bureau of Land Management (BLM) Arcata Field Office to propose an indirect approach roadside buffer, intended to meet multiple forest health objectives, including development of SOD-resistant and -resilient stands, conversion of tanoak-dominated

stands to conifers, a fuel break, and slowed pathogen spread toward Hoopa and Yurok lands as well as Redwood National and State Park. However, the infested trees were not removed due to accessibility issues. This strategic response continues to evolve as new infestations are detected.

In Big Sur (Monterey Co.), where millions of trees have been killed by *P. ramorum* since the mid1990s, management focus is on decreasing fuel loads. The Los Padres NF and the Nature Conservancy's Fire Learning Network initiated Fire Scape Monterey in the spring 2011, which brings community members and 27 public and private organizations together to work on local fire issues. Fuel reduction projects have been conducted at the Santa Lucia Preserve in Carmel Valley with hundreds of standing dead tanoaks felled and chipped on site. Additionally, the California Department of Forestry and Fire Protection is supporting multiple fuel reduction projects in the region, and the Palo Colorado community and Mid-Coast Fire Brigade have pooled resources to implement a self-funded project to collectively remove fuels along 4 miles of shared roadway.

In San Mateo Co., the San Francisco Public Utilities Commission (SFPUC) has been applying Agri-Fos® annually since 2008 as a large-scale field application for protection of a high-value tanoak stand above Crystal Springs Reservoir. The pathogen was first detected in the stand in 2011. The trunk spray application of potassium phosphite did not appear to impede SOD development in the stand, where about 15 percent of the trees died in the treated area (a level slightly higher than the untreated control plot). The SFPUC has discontinued trunk spray applications, but is continuing trials with removal of California bay laurel to protect coast live oak in another part of the watershed.

Research Highlights

Coast redwoods are nearly four times more likely to die during forest fires in SOD-infested forests than in non-infested forests, according to a recent study conducted by Metz and others (2013). Tanoak killed by SOD result in more fuel for wildfires as well as decreased moisture levels in affected forests as shade diminishes in the absence of trees. These dynamics make SOD-infested forests dryer and facilitate flame travel into the canopy, allowing fire to scorch nearby redwood crowns.

Hayden and others (2013) identified tanoak traits and seedling families with increased survivorship in planted trees, and a framework to further identify seed parents for restoration. Expanding on this, Richard Cobb and David Rizzo, UC Davis are working with the Hoopa, Yurok, SRNF, BLM-Arcata Field Office and others to determine the level of resistance to *P. ramorum* of culturally significant tanoaks in Humboldt Co.

Little is known about the basic ecology of tanoak, the tree species most susceptible to *P. ramorum* in California. Wright and Dodd (2013) conducted a pollination study in cooperation with the Midpennisula Regional Open Space District and demonstrated that tanoak is primarily an insect-pollinated species, though some level of wind pollination is likely. Prior to the study, it was assumed that tanoak was wind pollinated.

Cobb and others (2013) published a new conservation strategy for tanoak that incorporates both pathogen-centric management and host-centric preventative treatments to reduce rates of *P. ramorum* spread and local prevalence as well as increase protection of individual trees. The strategy is based on recent findings identifying heritable disease resistance traits, ameliorative treatments that reduce pathogen populations, and silvicultural treatments that shift stand composition, holding promise for increasing the resiliency of tanoak populations.

Resources

Progress on SOD research and management has been compiled in two volumes: the Proceedings of the Sudden Oak Death Fifth Science Symposium (available online at http://www.fs.fed.us/psw/publications/documents/psw_gtr243/) and Tanoak: History, Ecology, and Values published by the California Botanical Society as a special issue of Madroño, Volume 60, Number 2. Over a decade of research on tanoak is reviewed, and many of the papers were presented orally at "Tanoak Wild: A Celebration," June 22, 2012, as part of the Fifth SOD Science Symposium. 2013. The issue is available at http://www.calbotsoc.org/special_issues.html.

SODMAP mobile is a new app available for the iPhone and Droid. Developed by the UC Berkeley Forest Pathology and Mycology Lab, the app is intended for field use and allows the user to identify the locations of trees sampled for *P. ramorum* and determine the health of each tree at the time of sampling. The app can also calculate the risk of infection at the location where the user is by using the number of sampled trees in the area and proximity of positive trees. High- or moderate-risk ratings indicate action may be needed to preventively protect oak trees. This tool can assist in helping property owners and managers as well as tree care professionals make management decisions; however, other factors must be taken into consideration, such as host distribution, weather patterns, and land management goals.

Also new this year is "A Reference Manual for Managing Sudden Oak Death in California," by Swiecki and Bernhardt (2013), which provides background information and guidance for resource management professionals and landowners that are managing SOD in California.

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