

## Addressing *Phytophthoras* and Other Plant Pathogens in Restoration Plantings

The Phytophthoras in Native Habitats Work Group aims to minimize *Phytophthora* pathogen spread to native vegetation, especially sensitive, threatened and endangered plant species. In this document, we provide background on the issue and some recommendations targeted at prevention of plant pathogen introductions into California wildlands, restoration landscapes, and native plant nurseries. For more information see [www.calphytos.org](http://www.calphytos.org).

**I.A. Introduction.** Over the past several years, numerous *Phytophthora* (pronounced Fie-TOF-ther-uh) plant pathogens have been detected in California native plant nurseries and outplanted at habitat restoration sites. The discoveries include: 1) First detections in the USA of *Phytophthora tentaculata* (Rooney-Latham and others 2015) and *P. quercina* (Hillman and others 2016), along with over 50 other *Phytophthora* taxa on nursery stock (Swiecki and Bernhardt 2016); 2) New or new hybrid *Phytophthora* species of concern that surfaced in investigations of large scale restoration projects conducted primarily on water district lands in Northern California (Bourret and others 2016, Lyman and others 2016), and transmission line restoration areas in Southern California on the Angeles National Forest (2017 unpublished internal report, Frankel, PSW Research Station).

The inadvertent spread of exotic *Phytophthora* species into natural ecosystems is a threat to environmental, social and economic resources in restoration areas and adjacent wildlands. Restoration areas are conservation investments; those endowments are threatened by plant pathogen contamination. In this overview, the **Phytophthoras in Native Habitats Work Group** explains why we are concerned about these pathogen detections, and sets out current needs and recommendations to prevent and manage Phytophthoras and other plant pathogens in CA restoration areas.

**B. Why the worry?** New *Phytophthora* taxa and known pathogenic species were commonly found on native plant nursery stock, which raises concerns about outplanting of native plant nursery stock into sensitive habitats, where the plants can serve as a high risk pathway for introduction of plant pathogens into wildlands. Container plant movement can spread Phytophthoras long distances and facilitate their proliferation across landscapes. Once an area is contaminated, it is difficult to eradicate the pathogen and restore lands. Over the past twenty years, the sudden oak death pathogen, *P. ramorum*, was introduced to wildlands on horticultural nursery stock, it escaped into forest and killed millions of trees along the California Central Coast (Mascheretti and others 2008) and Southern Oregon (Kanaskie and others 2017). Nursery plants are the primary pathway for invasive pathogens into the United States, for example, the pathogens that cause white pine blister rust, and chestnut blight were both inadvertently introduced on nursery plants and went on to cause highly damaging, irreversible forest epidemics (Liebhold and others 2012).

To protect watersheds, and respond to the recent *Phytophthora* introductions on native plants, land managers suspended plantings, cancelled orders or invested millions in solarization and other treatments to clean-up contaminated sites but have achieved only partial eradication (Hillman and

others 2016, Lyman and others 2016). Avoiding planting is not an ideal long-term solution to *Phytophthora* prevention since many of the benefits of restoration are lost when nursery stock is prohibited. Here we provide background and needs to protect habitat in restoration areas from *Phytophthora* infection and spread.

## II. Who we are

The **Phytophthoras in Native Habitats Work Group** ([www.CalPhytos.org](http://www.CalPhytos.org)) is a voluntary coalition of California native plant nursery managers, land management agencies, researchers, and non-profit organizations. Formed in 2015, our primary purpose is to coordinate a comprehensive program of management, monitoring, research, education and policy to minimize the spread of *Phytophthora* pathogens in restoration sites and native plant nurseries. For a partial list of participating organizations see the Appendix.

## III. Goals and priorities

The Phytophthoras in Native Habitats Work Group aims to minimize *Phytophthora* pathogen spread to native vegetation and wildland habitats, especially those which contain sensitive, threatened and endangered species.

**Prevention is key.** The most effective approach to reduce the risk to native plants from *Phytophthora* pathogens is to raise plant cleanliness standards for growing, handling and use of California native plant nursery stock. By utilizing systematic sanitation practices in restoration nurseries environmental damage can be averted. We recommend improving phytosanitary practices through all steps in the restoration process. Best management practices for restoration nurseries and sites are available at [www.calphytos.org](http://www.calphytos.org).

Research is also needed to better understand the threat these pathogens pose to California flora and to develop monitoring and treatment methods.

Monitoring is needed to understand the extent of the problem and its impacts.

**IV.A. What are Phytophthoras?** The genus *Phytophthora* (pronounced Fie-TOF-ther-uh) is a group of microscopic organisms that includes some of the most devastating plant pathogens; the name *Phytophthora* means “plant destroyer.” *Phytophthora* is part of a larger group of organisms known as oomycetes which resemble other fungi such as molds but actually belong to a different major eukaryotic group called the stramenopiles. Although water and moist conditions is important for their infection processes and life cycles, most of the more than 150 described *Phytophthora* species are terrestrial (land dwelling) plant pathogens. Commonly called “water molds”, *Phytophthora* species produce swimming spores, called zoospores, and thrive under wet environmental conditions (Dick 2001).

Notorious Phytophthoras include *P. infestans* that causes potato late blight and led to the Irish potato famine of the 1840s, *P. cinnamomi*, which infects more than 2000 plant species and is particularly damaging in Australian wildlands, and *P. ramorum*, cause of sudden oak death. *Phytophthora* species are among the most destructive pathogens of agricultural crops and forests in the world (see Forest

Phytophthoras of the World; forestphytophthoras.org). However, not all *Phytophthora* species behave similarly; they have different host ranges and varying environmental preferences. Consequently, the level of damage varies with the combination of host plants, *Phytophthora* species, and site environmental conditions. The concern regarding *Phytophthora* species in nurseries and forests is also not new, but until recently, we did not realize the extent of infestation in CA native plant nurseries, and in restoration sites.

There is often little information on the risk of a particular *Phytophthora* species to a specific CA native plant host and ecosystem. The variability in environmental conditions (e.g. precipitation, soil type, topography, amount of disturbance), also increases the difficulty in defining risk. Due to the potential for irreparable, severe environmental damage to California's natural habitats, precautions to prevent pathogen introduction are warranted. This same conclusion was reached in a wide-ranging study of *Phytophthora* species in European ecosystems (Jung and others 2016).

**B. Examples of *Phytophthora* species problems in native habitats.** In Santa Clara County, *P. cactorum* was inadvertently introduced on planted Coyote ceanothus, *Ceanothus ferrisiae*, a rare serpentine endemic which is federally listed as endangered. Only three areas support *Ceanothus ferrisiae* in the wild; regrettably, one portion this rare habitat is now infested with several soilborne *Phytophthora* species that will be difficult or impossible to eradicate (Hillman and others 2016).

Another wildland concern is *P. cinnamomi* on lone manzanita, *Arctostaphylos myrtifolia*, which is federally listed as a threatened species. *A. myrtifolia* is endemic to lone formation soils in the Sierra foothills, in Amador County. *P. cinnamomi* was identified as the cause of large spreading mortality centers affecting large portions of many *A. myrtifolia* stands (Swiecki and others 2005, 2011). Genetic data indicates that these widespread infestations originated from several introductions (Swiecki and others 2005, 2011) and the unabated spread of *P. cinnamomi* is currently the greatest threat to the conservation of *A. myrtifolia*.

Sudden oak death, caused by *P. ramorum*, (Rizzo and Garbelotto 2003) and *P. lateralis* cause of Port-Orford cedar root disease (Hansen and others 2000) are particularly damaging, both were introduced on nursery stock, and went on to cause major forest epidemics in California and Oregon.

For more information on forest *Phytophthoras*, see <http://forestphytophthoras.org/>. For information on *Phytophthora* issues in CA native plants see [www.calphytos.org](http://www.calphytos.org).

## V. Recommendations

All native plants grown for restoration and outplanting in sensitive habitats are at risk for inadvertent plant pathogen introductions. Prevention is key! To manage the introduction and spread of Phytophthoras and other plant pathogens during restoration activities, utilize clean nursery stock grown with comprehensive best management practices. During site preparation, installation and maintenance, utilization of best management practices is also critical to reduce contamination risk. For detailed guidance on how to prevent and manage Phytophthoras during various aspects of restoration, including nursery plant production, see The Phytophthoras in Native Habitats Work Group "Restoration Guidance" at [www.calphytos.org](http://www.calphytos.org).

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## Appendix

### Partial list of participating organizations

AECOM;  
California Department of Fish and Wildlife;  
California Department of Food and Agriculture;  
California Native Nursery Network;  
California Native Plant Society;  
Central Coast Wilds;  
Fogiel Biological;  
Golden Gate National Parks Conservancy;  
Golden Gate National Recreation Area, National Park Service;  
Grassroots Ecology (formerly Acterra);  
HT Harvey and Associates;

Marin Municipal Water District;  
Midpeninsula Regional Open Space District;  
National Ornamentals Research Site at Dominican University of California;  
Oregon State University, Botany and Plant Pathology Department;  
Phytosphere Research;  
Presidio Trust;  
San Francisco Public Utilities Commission;  
Santa Clara Valley Water District;  
University of California Cooperative Extension, Marin County;  
University of California Cooperative Extension, Santa Cruz and Monterey Cos.;  
University of California – Berkeley, Forest Pathology and Mycology laboratory;  
University of California - Davis, Department of Plant Pathology;  
USDA Forest Service – Pacific Southwest Research Station;  
US Fish and Wildlife Service;  
The Watershed Nursery, Richmond, CA.