

## Frequently Asked Questions concerning

### *Phytophthora* species detected in California native plant nurseries and restoration sites

**1. What are Phytophthoras?** The genus *Phytophthora* (pronounced Fie-TOF-ther-uh) is a group of microscopic organisms that includes some of the most devastating pathogens of plants; the name *Phytophthora* means “plant destroyer.” *Phytophthora* is part of a larger group of organisms known as oomycetes (egg-fungi) which typically resemble other fungi such as molds and mushrooms but actually belong to a different major eukaryotic group called the stramenopiles. Although water and moist conditions may be 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.

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. However, not all *Phytophthora* species are created equal; they have different host ranges, and most cause less severe or less widespread damage. 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.

**2. Why are we concerned about root-rotting and other *Phytophthora* species in restoration plantings and other managed habitat areas?** In 2014-16, well over 50 *Phytophthora* taxa were identified in native plant nurseries and restoration sites, including *P. tentaculata* and *P. quercina* (both new to the USA); *P. uniformis*, a first detection in a US nursery, as well as new hybrid species; and new taxa still being described. In preliminary surveys conducted in CA, OR, and WA to estimate the prevalence of *Phytophthora* in native plant nurseries, approximately 25% of the nursery plant samples tested positive for at least one *Phytophthora* species.

The incidence and number of new taxa raises concerns about the outplanting of native plant nursery stock into natural habitats, where the plants can serve as a high-risk pathway for introduction of plant pathogens into wildlands.

Many *Phytophthora* species cause root rot on a wide variety of plant species. Infection can lead to serious diseases including stunted growth, decline, or plant death. If *Phytophthora* species are present in nursery stock and used in restoration plantings, the infected plant material is likely to perform poorly. Most importantly, infected nursery stock can infest the planting site itself, affecting both attempts at replacement planting and the health of adjacent site vegetation. Pathogen introductions can lead to degradation of the site’s ability to support native vegetation including sensitive species.

**3. Can you provide examples of *Phytophthora* species problems in native habitats?** In Santa Clara County, *P. cactorum* was inadvertently introduced on planted *Ceanothus ferrisiae*, a rare serpentine

endemic. Only 600 sites support *Ceanothus ferrisiae* in the wild; regrettably, this rare habitat is now infested with a soilborne pathogen that is difficult or impossible to eradicate.

Another wildland concern is *P. cinnamomi* on lone manzanita, *Arctostaphylos myrtifolia* at the Apricum Hill Preserve in the Sierra foothills (Amador County). *A. myrtifolia* is listed as rare in CA (Category 1B.2) in the CA Native Plant Society Inventory of Rare Species. This manzanita is endemic to the Sierra Nevada foothills of California in chaparral and woodland plant community on a distinctive acidic soil series and *P. cinnamomi* is causing large, expanding mortality centers.

Sudden oak death, caused by *P. ramorum*, and *P. lateralis* cause of Port-Orford cedar root disease 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).

**4. Do Phytophthoras only affect native plants or do they threaten other plants, as well?** Most of the *Phytophthora* species detected in native plant nurseries and restoration sites have also been found in horticultural nurseries, agricultural fields and orchards. For example, species like *P. cactorum* found in restoration nurseries and sites causes crown rot of California grown strawberries. Some *Phytophthoras* can be found in forests, typically in disturbed areas where natural vegetation is growing in populated locations or adjacent to gardens and farms.

**5. In what geographic area is *Phytophthora* on native plants a problem? Who is affected?** Additional surveys are needed to clearly delineate the risk and current distribution of *Phytophthora* species in native plant nurseries and restoration sites, as well as in natural areas on native or non-native vegetation, but we consider all of California to be at risk for *Phytophthora* introduction and spread. Oregon and Washington native plant nurseries and restoration areas are also being surveyed for *Phytophthoras* but, in general, *Phytophthoras* are a global problem.

In the USA, *P. tentaculata* infestations are known only in CA, in Alameda, Santa Clara, San Mateo, San Francisco, Monterey, Butte, Placer, Santa Cruz and Orange counties. For more information about *P. tentaculata* see the Retail Nursery & Garden Center IPM News, Volume 6, No. 3, ( December 2016), page 3-4, linked here: <http://ipm.ucanr.edu/PDF/PUBS/retailipmnews.2016.december.pdf>

For *Phytophthora* distribution and spread, there are large gaps in our knowledge, for example, we have little information on the impact of *Phytophthora* species in Southern California restoration sites. A preliminary investigation detected an infestation of a likely new *Phytophthora* species or new hybrid species in a restoration area on the Angeles National Forest. Additional surveys are needed to define the extent of the problem.

Restoration activities have been disrupted in San Mateo, Santa Clara, Alameda and San Francisco Counties. The plant pathogen problem is affecting flood control, public utility habitat mitigation and fire rehabilitation projects, open space, park and other land management areas, and the native plant nursery industry.

**6. Are all *Phytophthora* species harmful?** There are no *Phytophthora* species that can be considered to be completely harmless, but *Phytophthora* species do show varying degrees of pathogenicity to different hosts. Part of our concern is since containerized nursery stock is shipped, it can serve as a pathway for pathogen introductions all around the world. There are an infinite combination of plant species, ecosystems and environmental conditions and a pathogen that is benign in one area may be harmful in another. For example, *P. ramorum*, cause of sudden oak death, was introduced on nursery stock, and went on to kill millions of trees in California and Oregon. We do not know the exact origin of *P. ramorum* but genetic analyses clearly show *P. ramorum* was introduced, and then spread, on nursery stock.

**7. Are some *Phytophthora* species so common that they are no longer a concern?** *Phytophthora* species that are known to be in many parts of California (e.g. *P. cactorum*), are typically found in highly disturbed agricultural or urban areas. These species can cause tree and plant mortality when introduced to new areas or remote wildlands. The damage usually appears as radiating gaps in the canopy filled with dead or dying plants. The value and condition of the planting site are critical considerations in any estimation of the risk of harm from plant pathogen introductions and precautions are particularly important in rare plant habitat. The environment is degraded anytime *Phytophthora* infested nursery stock is outplanted and the California floristic province supports more than 2,000 endemic plant species that need to be protected from pathogen invasion.

**8. How do *Phytophthoras* spread in open spaces, parks or wildlands?** Under wet conditions, *Phytophthora* species produce sporangia that release swimming zoospores that seek out and, most commonly, infect host roots. They can also spread from the susceptible root of one plant to another when these come into contact. Many *Phytophthora* species also produce resistant spores, called oospores and chlamydospores, that can tolerate drying, even outside their host. These spores are spread by natural or human-assisted movement, which can occur by movement of infected plant material, contaminated soil, and water, including rain runoff. A limited number of species, such as *P. infestans* and *P. ramorum*, can move on air currents or wind-blown rain. *P. tentaculata*, and most of the other species found associated with native plants are soilborne pathogens that move primarily via natural or human-assisted movement of contaminated plants, water, or soil.

**9. Are there some native plant species that are not susceptible to *Phytophthora*?** No one can guarantee any plant species is immune to all *Phytophthora* species. In addition: 1. We do not know of any plant type (grasses, ferns, woody plants, etc.) that is not susceptible to at-least one *Phytophthora* species. 2. There are some *Phytophthora* species with broad host ranges spanning plant families. 3. The complete or even nearly complete host range of most *Phytophthora* species is unknown. 4. *Phytophthora* pathogens continually evolve to attack plants and plants evolve much more slowly than these microbes. 5. There is a vast array of ecosystems and environmental conditions, and a particular plant species may not become diseased until conditions are favorable to the pathogen.

Given the prevalence and large number of *Phytophthora* species circulating in the nursery trade and the wide range of hosts, trying to avoid *Phytophthora* issues strictly by avoiding known, highly-susceptible native host species (for example, sticky monkey flower, a known host of *P. tentaculata*) is of limited value. This is partly due to our limited understanding of host ranges regarding native plant species. However, in infested sites where *Phytophthora* eradication is not a viable option, and in which only one or two *Phytophthora* species are present, changing the planting palette may be a successful strategy for

managing the vegetation. Also, plant breeders have developed particular varieties of *Phytophthora* resistant plants, such as Monrovia's Guardian® series which uses root stock developed by Oregon State University that is resistant to *P. lateralis* (cause of Port-Orford cedar root disease).

**10. Is this plant pathogen battle a lost cause? Is the horse out of the barn, so to speak?** Movement of plants, whether within CA or globally has been steadily increasing, meaning the threat of a new disease introduction, similar to the sudden oak death epidemic, is greater than ever. There is still much that needs to be done to prevent further *Phytophthora* damage to CA habitats. There are vast wildland areas not yet infested and no single species is uniformly distributed across all landscapes. While there are many *Phytophthora* species that have the potential to engender disease, the cause is far from lost. Action must be taken now, to prevent *Phytophthora* species from being introduced into native habitats and developed landscapes.

**11. What are the most important measures a nursery should take to minimize the risk of *Phytophthora* plant pathogens in nursery stock?** A comprehensive, systematic approach to sanitation, scouting, and culture is required; every step in nursery production must be designed and monitored to exclude, prevent and manage plant diseases. The Working Group for *Phytophthoras* in Native Plant Habitats has produced guidelines for restoration nurseries for disease-free production in native plant nurseries. [Click here to see the Guidelines to Minimize \*Phytophthora\* Pathogens created by the Working Group for Phytophthoras in Native Habitats.](#)

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