

Spread and Development of *Phytophthora ramorum* in a California Christmas Tree Farm¹

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Abstract

The risk of conifers being infected by *Phytophthora ramorum* under natural conditions is poorly understood. In California, infected conifers commonly occur as understory plants beneath or adjacent to heavily infected plants like California bay laurel (*Umbellularia californica*). During wet periods, *P. ramorum* is known to produce a copious amount of spores from spots on infected leaves of this epidemiologically-important host. In Oregon, infection on California bay laurel is limited and infection of Douglas-fir (*Pseudotsuga menziesii*) trees has been limited to a few seedlings directly beneath infected tanoak (*Lithocarpus densiflorus*) trees in the regulated area in Curry County.

A number of studies are currently underway that are examining the influence of various environmental conditions, inoculum levels and host phenology on the infection of a number of hosts by *P. ramorum*. Most of these studies are being conducted on hosts growing within various types of mixed forest communities. Currently it is unclear what the level of risk is for infection of conifers in Christmas tree plantations, conifer nurseries, and coniferous forests. Laboratory studies indicated that infection of Douglas-fir seedlings is limited to a brief period of time right after bud break and is dependent on the inoculum concentration they are exposed to. It is unclear if conifer-to-conifer spread of this disease is possible.

To assess the potential risk associated with the movement of *P. ramorum* via infected Christmas trees, a better understanding of the factors that influence infection under field conditions is needed. The spread and development of *P. ramorum* has been monitored since 2005 in a 9.31 ha (23 ac) U-cut Christmas tree farm near Los Gatos, California. Located within a regulated county, this site provides a unique opportunity to study the spread of *P. ramorum* from the interface of a mixed forest containing highly susceptible hosts, into a Christmas tree plantation.

Conifers being grown at this site include Douglas-fir, grand fir (*Abies grandis*), giant sequoia (*Sequoiadendron giganteum*), Scots pine (*Pinus sylvestris*), white fir (*A. concolor*), and California red fir (*A. magnifica*). Some known *P. ramorum* hosts in the infested forest adjacent to the edge of the Christmas tree farm include: California bay laurel, madrone (*Arbutus menziesii*), big leaf maple (*Acer macrophyllum*), toyon (*Heteromeles arbutifolia*), coast redwood (*Sequoia sempervirens*), and tanoak. After mapping the perimeter of the farm to identify areas where ramorum blight was evident, 500 trees in the largest area with a past history of infection were mapped, tagged and measured for height.

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A series of six transects were established in 2005 from the edge of the forest into the Christmas trees in this area to monitor the spread of *P. ramorum*. The length of these transects ranged from 17 to 27 m. In addition to the established Christmas trees, in 2006 container-grown Douglas-fir and grand fir seedlings that had just broken bud, and small rhododendron plants, were also placed along three of these transects at approximately 0, 3.5, 8, and 13 m from the forest edge. The “0” meter locations on the transects were fully beneath overhanging bay branches. In some cases, there were also a limited number of overhanging bay branches above the 3.5 m locations. The level of infection and extent of shoot dieback was assessed on the tagged trees and containerized seedlings periodically during the spring and summer.

In both 2005 and 2006, new shoot infections on the Christmas trees developed only in the spring and initial dieback symptoms were limited to newly expanded shoot tips. Environmental conditions during spring 2005 were much more favorable to initial shoot tip infections than in 2006. In particular, along the six transects where grand fir were underneath the canopy of infected California bay laurel, virtually all of the new shoots were infected shortly after bud break in 2005. The progression of dieback on infected shoots of Douglas-fir and grand fir in 2005 progressed for about 4 weeks after the initial appearance of symptoms, typically spreading about 5 cm into the previous year’s growth. The extent of dieback did not increase between early summer and mid-November.

Infection rates and disease severity were also much higher among container grown seedlings that were placed beneath the bay canopy along the interface of the forest and Christmas tree farm in 2005. On May 19, 2005, 81.7 and 94.3 percent of the Douglas-fir and grand fir seedlings, respectively, that had been exposed since April 21, had become infected. The percentage of each seedling that was killed as the result of shoot dieback averaged 52.8 percent for the Douglas-fir and 81.2 percent for the grand fir. In 2006, infection of conifer seedlings and rhododendrons placed along the transects only occurred during exposure periods when precipitation occurred, and when the plants were in close proximity to infected California bay laurel.

Data collected during the past 2 years at this site, indicates that distance from infected plants (predominantly California bay laurel) within the forest is an important factor relating to the infection of the Douglas-fir and grand fir Christmas trees. Most of the infected Christmas trees and seedlings occurred within 4.4 m of the start of the transects. Virtually no infection was evident on Christmas trees that were 5 to 8 m away from the start.

Key words: *Phytophthora ramorum*, *Pseudotsuga menziesii*, *Abies grandis*, conifers, epidemiology, spread.

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