

Review of Current Information Regarding the Phytosanitary Risks of *Phytophthora ramorum* and North American Conifers¹

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On March 3, 2007 the North American Plant Protection Organization (NAPPO) sponsored a “Risks to Conifers” discussion panel to review the state of scientific knowledge regarding *Phytophthora ramorum* Werres, De Cock & Man in 't Veld and conifers and the potential for the pathogen to be transported with conifer forest products moving in international trade. This panel took place during the third Sudden Oak Death Science Symposium organized by the USDA Forest Service Pacific Southwest Research Station, and the California Oak Mortality Task Force (COMTF) in Santa Rosa, California. It was attended by over 100 participants, including researchers and forest managers from the United Kingdom, the Netherlands, Belgium, the United States, and Canada. A number of reviews were presented by leading scientists in the field of *P. ramorum*, followed by a general discussion on the gaps in scientific knowledge. A list of presenters and the titles of their talks is available at: http://nature.berkeley.edu/comtf/sodsymposium/schedule_sections.htm#risktoconifers

Current information indicates that only a few conifers are proven natural hosts of *P. ramorum* including: *Pseudotsuga menziesii* (Mirb.) Franco (Douglas-fir), *Sequoia sempervirens* (Lamb.) Endl. (coastal redwood) and *Taxus baccata* L. (common yew, not native to North America) (Davidson and others 2002, Maloney and others 2002, Lane and others 2004). Other North American conifer species have been observed in nature to demonstrate symptoms of the disease but have not been conclusively proven as hosts. In particular, *Abies grandis* (Douglas ex D. Don) Lindley (grand fir), *A. concolor* (Gord. & Glend.) Lindl. ex Hildebr. (white fir) and *Taxus brevifolia* Nutt. (Pacific yew) are listed as associated hosts (COMTF). Most of these plants are present in the most heavily affected areas of northern California where inoculum levels are extreme. Scientists currently agree that high inoculum levels appear to be essential for infection to occur in these species under natural conditions. Chastagner (2005) reported that in laboratory inoculation trials, more than 10,000 spores/ml were necessary to cause infection in Douglas-fir and grand fir.

Hansen (2007) reported that in Oregon where the disease is present primarily in a mixed evergreen - *Lithocarpus densiflorus* (Hook. & Arn.) Rehd (tanoak) woodland, *P. ramorum* infection has been observed in only one instance on Douglas-fir saplings located directly beneath an infected tanoak. On private forest lands in Oregon, Douglas-fir and coastal redwood seedlings have been routinely planted in areas where eradication treatments have occurred and have also been planted as “bait” seedlings adjacent to known infested tanoak stumps. These and other planted seedlings have been followed since 2003. *Phytophthora ramorum* has not been recovered from these planted seedlings or nearby hosts in annual monitoring to date, despite the persistence of inoculum in the soil (Goheen this Proceedings).

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Hansen (2007) also noted that in observations of conifers in Europe, infection has not been observed, even though the plants are adjacent to heavily infected rhododendrons.

Chastagner (2007) reported that in a Christmas tree plantation in California, symptom expression was limited to the plants within about 5 m of heavily infected *Umbellularia californica* (Hook. & Arn.) Nutt (California bay laurel) plants surrounding the plantation. Chastagner (2007) also reported that no sporulation has been detected on naturally infected Douglas-fir and grand fir shoots, which suggests that there is a low risk of spread from these conifers. Infection of Douglas-firs and grand firs in the plantation was restricted to emerging shoots that resulted in flagging at branch tips or canker development on branches, but stem infections were never observed. Until the recent recovery of *P. ramorum* from Pacific yew stems in the wild (Bienapfl and others 2006), the occurrence of the pathogen in wood of naturally infected conifers has never been reported, although lab inoculations demonstrate that it is possible.

Coastal redwood was reported by Garbelotto (2007) to be the third most commonly infected plant in the *P. ramorum* infection zone in northern California. However, infection levels of coastal redwood are relatively small when compared to the levels of infection in tan oak and bay laurel.

Numerous other conifers have been artificially tested. Webber (2007) reported that more than 40 species had been tested in the United Kingdom (U.K.) and many of these artificial inoculations have been reported on the U. K.'s Central Science Laboratories' website: Risk Analysis for *Phytophthora ramorum* (<http://rapra.csl.gov.uk>). Hansen (2005), Chastagner and others (2005) and others have undertaken similar laboratory inoculations. Artificial inoculations of *Pinus*, *Picea*, *Larix* and other conifers have shown varying degrees of host response. Most show similar symptoms to those susceptible conifers found in nature including tip-dieback and shoot blight. Some of have also shown lesions in the wood when the pathogen is inoculated into the stem. Garbelotto (2003) reported lesions in the stems of *Pinus radiata* D. Don and Brasier and others (2005) reported lesions occurring in *Picea* following stem inoculation. However, most scientists conclude that laboratory inoculations are difficult to extrapolate to forest conditions, given that spore loads necessary to cause infection may not occur in natural environments.

In conclusion, panel participants agreed the risks of conifer commodities (lumber, logs, and os forth) carrying the pathogen to new areas is extremely low. To date, the known incidence of long distance pathogen movement has been restricted to movements of infected nursery stock, particularly high risk hosts such as rhododendron, the movement of infected soils or the movement of more highly susceptible deciduous plant parts such as leaves and branches. It is possible that conifer plant parts such as branches may pose a risk for moving the pathogen, but transmission of the pathogen by this method or even sporulation on conifer branches has not been observed. However, potential for sporulation of the pathogen on conifer foliage and green succulent tissues should be investigated. A number of conflicting reports on the thermal requirements to kill *P. ramorum* in wood (particularly in deciduous wood) demands further analysis. Finally, although the likelihood of the pathogen moving within the wood of conifers appears very low, the potential that conifer logs felled within infested stands (in other words in bay laurel, rhododendron, or tanoak woodlands) may carry contaminating spores should also be investigated. It is unclear, if in such circumstances sufficient spores could survive transportation and be distributed to cause infection elsewhere.

Key words: *Phytophthora ramorum*, sudden oak death, conifers, phytosanitary risks.

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