

Losses Caused by Annosus Root Disease in Pacific Northwest Forests¹

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Abstract: Annosus root disease affects three tree species groups in the Pacific Northwest--the hemlocks, the pines, and the true firs. The disease causes significant decay and stem breakage in old growth western hemlock stands but little damage in young managed stands. Losses in ponderosa pine are minor over most of the region but can be substantial in selectively harvested stands on dry plant association types in southeastern Oregon. Annosus root disease is very damaging in white and grand fir stands east of the Cascades. The disease may limit management of these species in stands that have experienced more than one selective harvest entry.

In the Pacific Northwest, annosus root disease, caused by Heterobasidion annosum, results in losses in three tree species groups--the hemlocks, the pines, and the true firs.

HEMLOCKS

Western hemlock (Tsuga heterophylla (Raf.) Sarg.) in westside stands and mountain hemlock (T. mertensiana (Bong.) Carr.) in the high Cascades are commonly infected by Heterobasidion annosum. Mountain hemlock is currently not an important species for forest management in the Pacific Northwest, but western hemlock is very important and becoming more so. H. annosum-infected western hemlocks 150 years old or older suffer significant amounts of decay loss and considerable mortality due to stem breakage (Buckland and others 1949, Foster and others 1954). However, stands under 150 years old, though frequently highly infected, seldom suffer unacceptable losses (Goheen and others

1980). There is almost no mortality due to annosus root disease in young managed stands, decay loss is generally below 4 percent of the merchantable cubic foot volume, and there appears to be no growth loss associated with the disease.

PINES

Heterobasidion annosum is widespread in pine stands in eastern Oregon and Washington (Hadfield and others 1986). Lodgepole pine (Pinus contorta var. murrayana (Grey. and Balf.) Engelm. is commonly infected in central Oregon, but as yet there is little evidence of significant loss (Schmitt 1982). Routine pest surveys throughout the region commonly reveal the presence of H. annosum fruiting bodies in ponderosa pine (Pinus ponderosa Laws.) stumps. Significant ponderosa pine mortality, however, is not common over the range of the fungus. In the Pacific Northwest, it is apparently limited to localized sites that have certain site characteristics.

On the Bly and Lakeview Ranger Districts, Fremont National Forest, and the Lakeview District of the Bureau of Land Management (BLM), annosus root disease is very damaging in some ponderosa pine stands. In a pest evaluation of 700 acres of BLM land in this area, annosus root disease was found in 30 percent of all survey plots (40 BAF variable radius plots located on a 100 by 100 meter grid) within the pine-stocked portion of the unit (Goheen 1983). Six percent of the ponderosa pine greater than 6 inches in diameter at breast height (DBH) (containing 5 percent of the basal area) was dead due to annosus root disease. Another 7 percent of the pine over 6 inches DBH (containing 5 percent of the basal area) although still alive, had detectable infection by H. annosum. Trees of all size classes were affected. The disease had been active in the stand for some time and had greatly affected stocking in disease pockets. Overall pine stocking in disease pockets was reduced to 77 percent of that in healthy portions of the stand. Basal area reduction was even more dramatic. Disease pockets averaged only 44 percent as much square foot basal area as healthy areas. Western juniper, growing in the vicinity of infected ponderosa pine stumps, was also being severely affected by

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annosus root disease. The area surveyed was an uneven-aged, multistoried ponderosa pine-western juniper stand interspersed with sagebrush flats, grassy creek swales, and lava beds. At least two past selective harvest entries had occurred on the site.

Surveys of two similar stands on the Bly Ranger District showed active annosus root disease in 25 and 21 percent of the plots (20 BAF variable radius plots on a 40 by 100 meter grid) on 50 and 30 acres respectively.³ In the first stand, basal area was reduced 54 percent in plots with disease, and in the second stand, basal area was reduced 31 percent.

The Panelli Seed Orchard, also located on the Bly District, is experiencing significant losses due to annosus root disease. The plant association is ponderosa pine/juniper/mountain-mahogany/bitterbrush/big sagebrush/fescue (CP-C2-11), which is indicative of a dry site. Trees were planted in 1981 after stumps had been treated with borax. Stumps were cut flush with the ground in August 1982 and were not borax-treated. Seedling mortality was first noticed in 1984. By 1986, mortality, confirmed as annosus-caused, was scattered throughout the plantation. Twenty-six high-value orchard trees were dead due to annosus root disease in 1987. By 1988, an additional 48 trees had been killed.

Centers of mortality caused by annosus root disease in other southeast Oregon stands are also commonly associated with very dry sites. In an attempt to characterize the type of site where annosus root disease could become a management concern, fifty infection centers on the Bly District, Fremont National Forest, were visited by the Area Ecologist and Forest Pest Management pathologists (Hopkins and others 1988). Mortality was found to be centered around large old ponderosa pine stumps, normally in excess of 18 inches diameter inside bark (DIB). Ten- to thirty-year-old regeneration was most commonly killed, but mortality could involve trees of any size or age class located within 30 feet of infected stumps. Western juniper was frequently killed. Significant mortality apparently did not develop for 10 to 15 years following logging. It was observed mostly around 15- to 30-year-old stumps. Distance from stumps to dying trees appeared consistent with a spread rate of approximately 1 foot per year.

Most of the diseased tree sites evaluated had a high degree of disturbance. All had had

multiple harvest entries and had been grazed for many seasons by livestock. Many had displaced or compacted soils. Most of these sites are on or close to the forest/non-forest interface. The most common plant association type was ponderosa pine/wooly wyethia (CP-F1-11) transitional to ponderosa pine/serviceberry/Wheeler's bluegrass, and upslope ponderosa pine-white fir/snowberry/starwort (CW-S3-13) (Hopkins 1979). Other less frequently encountered associations were ponderosa pine/bitterbrush/fescue (CP-S2-11) and ponderosa pine/bitterbrush/needle-grass (CP-S2-12). Abundant shrub/herb cover created a very competitive environment for tree establishment and growth on most diseased sites. The average collective shrub canopy cover was 32 percent (range from 2-95 percent), and the average collective herb cover was 49 percent (range was 21-80 percent). Shrubs in decreasing order of importance were squaw carpet, serviceberry, chokecherry, manzanita, Oregon grape, currant, and rose. Herbs were wooly wyethia, mountain brome, Ross' sedge, squirreltail, lupine, yarrow, ragwort, strawberry, and occasionally fescue, needlegrass, and Wheeler's bluegrass.

Prevalence of annosus-caused mortality on very dry sites near the forest edge has also been observed on the Ochoco National Forest, particularly on the Paulina District at the eastern boundary of the forest. While these sites have not been as closely scrutinized as those on the Fremont National Forest, it is believed that site characteristics are similar.

With the exception of the Panelli Seed Orchard, the sites described above have all been managed under a selective harvest system. As more and more clearcuts planted to pine are prescribed for this area, there is great concern over the role *H. annosum* may play in these stands, particularly since many of the stumps apparently contributing inoculum that caused tree infection at Panelli Seed Orchard were smaller than the 18--inch DIB rule of thumb that seems to apply in selectively harvested stands. A survey of a 10-year-old ponderosa pine plantation created after a clearcut in the northern portion of the Bly District revealed that 57 percent of 112 ponderosa pine stumps examined were *H. annosum*-infected based on the presence of fruiting bodies.⁴ Eight percent of the 248 plantation trees examined were infected. The plantation is located on a dry site on pumice soils. A similar survey of a 20-year-old plantation on a moister site revealed that although 48 percent of the stumps were

³Data on file, Forest Pest Management, Pacific Northwest Region, USDA Forest Service, Portland, Oregon 97208.

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infected, annosus root disease had caused no mortality in the plantation. Other moist sites with younger plantations that have been stump-surveyed show similar levels of stump infection, but so far no annosus-caused mortality of the young trees.

In selectively managed stands, we believe that we now know which site characteristics and stand conditions contribute to a high risk of annosus-caused tree mortality. We speculate that H. annosum kills trees that are under stress on dry sites and that more vigorous trees on moister sites, while frequently exposed to infection, either do not become infected or tolerate infection. In pine plantations created after clearcutting, however, we do not yet know the relationships between annosus mortality and site and stand characteristics. Inoculum levels are high, trees are planted close to stumps, and planted trees may be more susceptible to H. annosum than naturally seeded trees. Further investigations are planned.

TRUE FIRS

Heterobasidion annosum already may be the most damaging pathogen of true firs east of the Cascade Mountains in the Pacific Northwest, and losses due to annosus root disease appear to be steadily increasing. Significant amounts of white fir (Abies concolor (cord. and Glend.) Lindl.) and grand fir (Abies grandis (Dougl.) Lindl.) mortality attributable to annosus root disease began to be noted in the late 1970's. Subsequently, the more we have looked for it, the more annosus root disease we have found on the true firs (Filip and Goheen 1982, Filip and Goheen 1984). It appears that the management approach of repeated selective harvests used in many of the mixed conifer stands has greatly favored the disease.

Forest Pest Management has done detailed evaluations of annosus root disease-caused losses on several eastside National Forests and has also examined the relationship between number of past selective harvest entries and disease severity (Schmitt and others 1984). Surveys have been completed on the Fremont National Forest in southern Oregon and the Ochoco National Forest in central Oregon. Results of intensive stand examinations of 98 randomly selected stands with white or grand fir components on each Forest showed the following percentages with annosus root disease affecting the fir:

Type of Stand	Percent	
	Ochoco	Fremont
Unentered Stands	0	12
Entered Once	50	40
Multiple Entries	33	100

These results show that incidence of annosus root disease is very high in entered stands on both Forests. The average percentage of the true firs infected and killed by H. annosum in the three stand types were as follows:

Type of Stand	Average Percentage	
	Ochoco	Fremont
Unentered Stands	0	0.04
Entered Once	0.5	1.7
Multiple Entries	2.9	20.8

Thus, much more infection and associated mortality occurs in entered stands than unentered stands, and by far the greatest incidence of infection was found in stands that had experienced more than one entry. Within the multiple-entry stand class, stands in which the longest times had elapsed since the initial harvest exhibited the greatest amount of annosus root disease-caused mortality. For example, 69 percent of all white fir were dead due to the disease in a stand on the Lakeview Ranger District, Fremont National Forest, that was first logged in 1938.

The greater amount of annosus root disease in stands with multiple stand entries (and therefore, the largest numbers of stumps, and, in most cases, the oldest stumps) undoubtedly reflects efficient use of stumps as infection courts by H. annosum. Mortality caused by annosus root disease almost always occurs in firs within 20 to 40 feet of old, infected true fir stumps, and virtually all stumps that serve as infection foci are 18 inches or greater in diameter. Distances from stumps to current mortality indicate a radial spread rate across root systems of between 1 and 2 feet per year. Firs of all size classes are killed and disease centers become unstocked pockets within the stands unless other tree species are present. We have seen no evidence of disease cross-over from true firs to any other tree species.

Differences between the Ochoco and Fremont National Forests in amount of annosus root disease-caused mortality were probably due to the different harvesting histories of the two Forests. Widespread cutting of large white firs began considerably earlier on the Fremont than on other Forests in the Region.

White and grand firs are fast growers, release well, and are prolific seeders that establish themselves naturally on all but the coldest and driest sites. They are shade-tolerant, fire-intolerant species that have increased greatly on all eastside forests in the last 80 years due to fire exclusion and the preferential removal of pines, western larch, and Douglas-fir during selective

harvest operations. Currently, there is a controversy concerning the best future management approach for mixed Eastside stands with major fir components in the Pacific Northwest. Some forest managers are reluctant to incur the costs associated with regeneration harvests and reestablishment of shade-intolerant tree species when naturally established true fir understories already exist. They advocate uneven-age management schemes involving continued selective removal of overstory trees and release of fir understories. There is also considerable agitation for use of uneven-age systems by public groups that oppose regeneration harvesting, especially clearcutting. On the other hand, many silviculturists believe that continued selective harvesting in mixed types is unacceptable due to the numerous existing and potential pest problems that affect the true firs. Annosus root disease may ultimately figure as a deciding factor in this debate.

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