Losses and Impact by Region

Distribution and Impacts of Annosus Root Disease in Forests of the Northern Rocky Mountains[1]

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Abstract: Annosus root disease is widely € distributed in the northern Rocky Mountains. € Stump infection often results in tree mortality € occurring in progressively expanding root disease € centers, in groups of various sizes, and as € scattered individuals. €

Distribution and relative abundance of € annosus root disease vary by host species and € geographic area. Most conifer species are € infected, but true firs and ponderosa pine are € most commonly infected. Infection by H. annosum€ is frequently observed in managed stands, often € associated with bark beetles and other fungal € root pathogens. €

Effects of tree mortality resulting from € infection by H. annosum may have both positive € and negative impacts on resource and ecosystem € values for a single site. Insofar as possible, € the net effect of annosus root disease must be € determined on a site-specific basis if impacts € are to be accurately assessed. To do this, as € well as to assess site associations and to € determine management implications, much more € information relating to distribution and € abundance of annosus root disease must be € obtained. €

Distribution and impacts of H. annosum in € forests of Idaho, western Montana, and northern € Utah--the northern Rocky Mountains--are reported € here. Forest types and disease expression are € relatively similar throughout the area. € Although, occasionally, deciduous trees and € shrubs become infected, the emphasis in this € report is on the infection of coniferous tree € species. €

Generally, annosus root disease of conifers € occurs in progressively expanding disease € centers, in tree groups of various sizes, and in € scattered individuals. One or more host species € may be involved in disease centers which often € originate around stumps and contain dead and € dying trees on the margins. Groups of infected € trees may involve from several to hundreds of € trees with detection being most often associated € with bark beetle activity. Individual tree € infection occurs as scattered trees, and, as with € group mortality, detection is often associated € with bark beetle activity. €

Information about the distribution and € abundance of annosus root disease in the northern € Rocky Mountains contained in this report is based € on a limited number of available literature € reports, discussion with pest management € specialists and researchers in the northern Rocky € Mountain area[3], and personal observations. Few € surveys of distribution and abundance have been € reported. Available information is, thus, very € subjective being based largely on chance € examination of trees that have attracted € attention, primarily windthrown trees or those € with unhealthy or dead crowns. €

Impacts of root diseases, including annosus € root disease, to forest trees have not been well € quantified. Effects of root diseases on various € forest resource management objectives, except in € site-specific cases, have been even less well € quantified. Impact considerations of annosus € root disease in forest resource management are € discussed. €

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DISTRIBUTION €

In the northern Rocky Mountains, most € coniferous tree species are affected by annosus € root disease, but distribution and relative € abundance vary considerably by species. This € information is summarized in table 1 and is € discussed in more detail by specific host or host € group below. €

Ponderosa Pine (*Pinus ponderosa* Laws.)€

Annosus root disease occurs throughout € ponderosa pine type forests in the northern Rocky € Mountains. Sapling and pole-size ponderosa pines € are affected in expanding disease centers, € frequently, but not always, originating around € stumps. These centers, generally less than 0.25 € acres (0.1 hectares) in size, are common in € southern Idaho and western Montana--they are € occasionally noted in northern Idaho. €

Table 1--Distribution and relative abundance of annosus root disease in conifer € host tree species in the northern Rocky Mountains. €

		Disease centers		Scattered individual/€ group infection
Host	Location[1]	Abundance	Size (Acres)	Abundance
Ponderosa pine	N.ID	Occasional	0.1-1.0	Occasional
	SW.ID	Common	<0.25	Occasional
	W.MT	Common	0.1-1.0	Common
Douglas-fir	N.ID	Common	>10.0	Common
	S.ID	Rare	<0.05	Rare
	W.MT	Occasional	0.1-5.0	Rare
	N.UT	Not Observed		Rare
Engelmann Spruce	N.ID	Not Reported		Common[2]
	S.ID	Not Reported		Occasional[2]
	W.MT	Occasional	0.1-20.0	Common[2]
Lodgepole Pine	N.ID	Not Reported		Rare
	S.ID	Not Reported		Rare
Western Larch	N.ID	Not Reported		Rare
Grand Fir	N.ID	Common	1.0-10.0	Common [2]
	SW.ID	Occasional	<0.05	Common[2]
	W.MT	Common	1.0-5.0	Occasional[2]
White Fir	N.UT	Not Reported		Rare
Western White Pine	N.ID	Occasional	>0.25	Common[2]
	W.MT	Not Reported		Occasional[2]
Western Red Cedar	N.ID	Not Reported		Rare
	W.MT	Not Reported		Rare
Western Hemlock	N.ID	Rare	0.1-1.0	Occasional
	W.MT	Not Reported		Rare
Subalpine Fir	N.ID	Common	>10.0	Common[2]
	S.ID	Occasional	>20.0	Common[2]
	W.MT	Common	>10.0	Common[2]
	N.UT	Occasional	1.0-5.0	Common[2]
Whitebark Pine	ID	Not Reported		Rare

[1]Locations are the northern (N.), southern (S.) and western (W.) and € southwestern (S.W.) portions of Idaho (ID), Montana (MT), and Utah (UT). €

[2]Occurs as root and butt rot. €

In southwestern Idaho it is not uncommon to € detect two to four disease centers per acre in € cutover ponderosa pine stands regenerated with € ponderosa pine. In one such area near Boise, € Idaho, annosus root disease centers have been € monitored for a number of years (Marshall and € Hoffman 1983). In this area, 34 disease centers € scattered throughout a 14-acre (5.6 hectare) € ponderosa pine stand were identified 10 years € following establishment of regeneration. Disease € centers originated around stumps which ranged in € size from 9 inches (22.5 centimeters) to 37€ inches (81.4 centimeters). About one-third of € the stumps initiated centers. At last € measurement, centers ranged in size from 15 € square feet (1.4 square meters) to 935 square € feet (84.15 square meters), and about half of € them continued to be active. €

Annosus root disease in older ponderosa pines € may occasionally result in either direct € mortality of individual scattered trees (Williams € and Haglund 1976) or it may predispose trees to € bark beetle attack. Direct mortality associated € with annosus root disease is often found in € western Montana and only occasionally in Idaho. € Annosus root disease is often found in pines € attacked by bark beetles in other western forests € (Cobb et al 1974), but this relationship has not € been thoroughly evaluated in the northern Rocky € Mountains. €

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco.)€

Douglas-fir is infected by H. annosum€ throughout its range, but infection is less € frequent than on ponderosa pine. Infection € occurs primarily as a root rot and is often € associated with bark beetle activity[4] (Partridge € and Bertagnole, unpublished[4]). €

Root disease centers, involving Douglas-fir € of all sizes and several root pathogens including € H. annosum, are common only in northern Idaho. € They are less frequent in western Montana and € southwestern Idaho and have not been observed in € southeastern Idaho or northern Utah. In € southwestern Idaho, Douglas-fir is rarely € affected in disease centers except when ponderosa € pine is involved. In this area, other root € pathogens are not frequently associated with € infection by H. annosum. €

Size of disease centers seems to vary € directly with abundance. Large centers, up to 10 € acres in size (4 hectares), are present in € northern Idaho; smaller centers occur in € southwestern Idaho. €

[4]Unpublished data on file at the College of € Forestry, Wildlife, and Range Sciences, € University of Idaho, Moscow. €

Annosus root disease also occurs on scattered € individual and small groups of pole-size and € larger Douglas-fir trees. Annosus root disease € is relatively common in scattered Douglas-fir in € northern Idaho (Hagle personal communication € 2/89), while in southern Idaho infection is € rarely observed (Partridge and Canfield 1978). € In a summary of information concerning excavation € of root systems of about 450 green and declining € Douglas-fir trees throughout northern and € southern Idaho, Partridge and Bertagnole € (unpublished[4]) report that 2 to 3 percent of € the trees were infected with H. annosum. Over 90 € percent of the infected trees were found at € elevations above 5,000 feet (1,520 meters). In € western Montana and northern Utah, annosus root € disease of scattered trees has been rarely € observed. €

Engelmann Spruce (*Picea engelmanii* Parry)€

Annosus root disease of Engelmann spruce has € been reported only in Idaho and western Montana. € Disease centers caused by H. annosum have been € reported only in western Montana where they reach € 20 acres (8 hectares) in size. €

Infection of individual pole-size and larger € spruce trees results in a root and butt rot. € Infection of individual trees occurs commonly in € western Montana, occasionally in northern Idaho, € rarely in southern Idaho, and not at all in € northern Utah. €

Grand Fir (*Abies grandis* (Dougl.) Lindl.)€

Infection of grand fir by H. annosum results € in a root and butt rot throughout this host's € range often in association with other fungal root € pathogens and/or bark beetles. €

Root disease centers, often involving H. € annosum, commonly occur in northern Idaho and € western Montana but only occasionally in € southwestern Idaho. Size of disease centers € ranges from 0.1 acre (0.04 hectares) to more than € 10 acres (4 hectares). Root disease centers are € estimated to occupy about 3 to 5 percent of the € forested acreage on northern Idaho forests € (Williams and Leaphart 1978, James and others € 1984). €

Infected individual or small groups of dead, € pole-size and larger trees are observed more € abundantly than disease centers throughout the € range of grand fir. Infected trees are often € attacked by the fir engraver beetle, Scolytus€ ventralis LeConte (Partridge and Miller 1972). €

Several fungal root pathogens may be involved € with root disease of grand fir. Pathogens € involved vary by geographical area. In northern € Idaho, Phellinus weirii (Murr.) Gilbn. and € Armillaria spp. occur with much greater frequency € than H. annosum. Miller and Partridge (1973) € report that in excavation studies of grand fir € about 4 percent of all trees examined and 6 € percent of all root-rotted trees examined were € infected by H. annosum. In southern Idaho, the € opposite is true with H. annosum being by far the € most commonly encountered root pathogen. The € fungus can be easily found almost anywhere grand € fir occurs in southern Idaho. €

Endemic activity of the fir engraver beetle € regularly exposes a few scattered individual or € small groups of trees. But, during drought € years, beetle activity and exposure of diseased € trees often increases dramatically. Such has € been the case in Idaho in 1987 and 1988. During € that period, thousands of dying trees were € detected during routine aerial surveys € (Livingston and others 1988, Knapp and others € 1989). It is likely that not only root disease € but also moisture stress, resulting from several € consecutive years of below-normal precipitation, € predisposed trees to beetle attack. €

Western White Pine (*Pinus monticola* Dougl.)€

Annosus root disease centers occur € occasionally in western white pine in northern € Idaho. They often originate around stumps and € involve seedling- and sapling-size white pines in € patterns reminiscent of annosus disease centers € in ponderosa pine (Partridge, personal € communication 2/89). Seldom do they exceed 0.25 € acre (0.1 hectare) in size. This pattern of € activity has not been reported in the western € white pine forests in western Montana. €

Heterobasidion annosum is sometimes found in € conjunction with Armillaria spp. in old growth € western white pine trees. Infection commonly € results in a root and butt rot in northern € Idaho--less commonly in western Montana. Annosus € root disease is most often detected as scattered € individual trees which have been attacked by the € mountain pine beetle (Dendroctonus ponderosae€ Hopkins) (Ehrlich 1939). €

Lodgepole Pine (*Pinus contorta* Dougl.), Western€ Larch (*Larix occidentalis* Nutt.), White Fir€ (*Abies concolor* (cord. & Glend.) Lindl.) and€ Whitebark Pine (*Pinus albicaulis* Engelm.)€

Infection of these species reportedly occurs € rarely, only on scattered individuals, and varies € by geographical area. Annosus root disease has € been observed on lodgepole pine in Idaho and € western Montana, on western larch and whitebark € pine in Idaho, and on white fir in northern Utah. €

Western Red Cedar (*Thuja plicata* (Donn)) and€ Western Hemlock (*Tsuga heterophylla* (Raf.)€ Sarg.)€

Annosus root disease has not been frequently € reported on either of these species anywhere in € their respective ranges. Western hemlock is € rarely affected in disease centers that approach € 1 acre (0.4 hectare) in size (Hagle, personnal [sic]€ communication 2/89). Disease centers involving € western red cedar have not been reported. €

Heterobasidion annosum occurs occasionally in € scattered western hemlock but rarely on scattered € western red cedar (Partridge and Miller 1972, € Koenigs 1969). When detected, infection often € appears to be associated with stumps exposed € during harvest activities. €

Subalpine Fir (*Abies lasiocarpa* (Hook.) Nutt) €

Heterobasidion annosum infects subalpine fir € throughout its range resulting in a root and butt € rot. Progressively expanding root disease€ centers involving all sizes of trees commonly € occur in northern Idaho and western Montana. € Disease centers occur occasionally in southern € Idaho and rarely in northern Utah. Size of € disease centers varies from less than 0.1 acre € (.04 hectare) to 20 acres (8 hectare). €

Scattered individual or small groups of trees € are commonly infected throughout this host's € range (Partridge and Miller 1972, Knapp and € others 1988, Tegethoff 1973). Infection is most € often detected in pole-size and larger trees € attacked by the western balsam bark beetle, € Dryocetes confusus Swaine (Dubreuil 1982, Tkacz € 1983). In Utah, root-diseased subalpine fir are € often infected by both H. annosum and Armillaria€ spp. (Tkacz 1983). €

Thousands of subalpine fir were killed by the € western balsam bark beetle throughout southern € Idaho and Utah in the early 1980's (Knopf 1980). € Heterobasidion annosum has been detected in these € trees in some cases, but surveys to determine € degree of association have not been conducted. €

As noted above, pathologists have a fair idea € regarding how and where annosus root disease € affects the various conifer species in the € northern Rocky Mountains. Nevertheless, few € systematic surveys have been conducted, reports € often conflict, and few substantiated site or € stand associations can be made as has been done € in the southeastern United States (Anderson and € others 1980). To remedy these problems, € additional information concerning annosus root € disease must be collected. €

IMPACT CONSIDERATIONS €

The traditional connotation of tree root € disease is that it results in tree mortality and € growth loss, thus having a negative effect on € fiber or board production. Evaluating effects of € annosus root disease on tree growth and mortality € might appear rather simple--so many board feet of € lumber can be obtained from a dead tree of a € certain size or so many trees can be grown on a € given area occupied by root disease centers. € However, before impacts of root disease on the € timber resource can be realistically evaluated, € several questions must be addressed. These € include: €

* What is the market value of the particular € tree species being affected? €
* Could or would affected trees be harvested? €
* What is the effect of tree mortality on € long-term harvest scheduling and economics? €
* What is the long-term effect of implementing € management actions that greatly enhance the € probability of stump infection and pathogen € spread? €
* How does infection, either in scattered € trees or in disease centers, affect tree € regeneration? €
* How large will disease centers become? €

All things considered, tree mortality € associated with annosus root disease in € commercial forest areas generally has a negative € effect on the timber resource value. €

Other resource values in a forest environment € may also be affected, either positively or € negatively. Major non-timber resource values € include: esthetics and recreation, wildlife, € water production, and livestock range. These € non-timber resource values are receiving € increased attention as a result of planning € efforts and resource allocations on National € Forests in the northern Rocky Mountains. €

Esthetics and recreation opportunities are of € prime importance in developed forest sites such € as campgrounds and associated areas, € administrative sites, around dwellings, and in € other areas heavily used by people. While tree € mortality results in degradation of esthetic € values, loss is substantially compounded when € root-decayed trees fail resulting in damage to € area improvements or causing personal injury. € Discussion of root diseases that affect trees in € campgrounds are contained in several publications € (Wagener 1963, Mills and Russell 1981). Potential € for impact is directly proportional to tree size, € proximity to improvements, and, of course, the € extent of disease development (Paine 1971). Tree € mortality generally has a negative effect on € esthetic and recreation resource values. Value€ of trees used for these purposes is often € considerably greater than for trees used for € timber. €

The value of root-diseased trees relative to € the wildlife resource is much more difficult to € assess. Depending on site-specific management € emphases, dead trees may be much more valuable € than green trees, or the opposite may be true. € For example, the value of dead trees as perch € trees for raptors, for maintaining populations of € rare and endangered species of cavity-nesting € birds, or of fallen trees for debris recruitment € to aid fisheries may be very high. Conversely, € the value of green trees for providing hiding and € thermal cover to big game animals may be very € high. €

Other forest resource values are likewise € variably affected by annosus root disease. €

In addition to the effects of root disease on € vegetation, effects on other facets of the € ecosystem must also be factored into impact € considerations. Some values of trees to the € ecosystem, such as abatement of soil erosion by € wind or water, are obvious. More profound€ values, such as the relationship of green trees € to global climate or the value of decaying wood € to soil improvement (Jurgenson and others 1977; € Franklin and others 1981), have only recently € received much attention. €

On any given site, tree mortality caused by € annosus root disease or other pests can have both € positive and negative effects on resource or € ecosystem values. The determination of net € effect requires knowledge of site-specific € resource or ecosystem values as well as specific € knowledge of distribution and abundance of € annosus root disease. €

REFERENCES €

Anderson, R.L.; Fisher, V.; Mistretta, P. 1980. € How to recognize annosus-prone forest sites. € Forest Farmer October, 1980; 6-7. €

Cobb, F.W., Jr.; Parmeter, J.R., Jr.; Wood, D.L.; € Stark, R.W. 1974. Root pathogens as agents € predisposing ponderosa pine and white fir to € bark beetles. In: E.G. Kuhlman, ed., € Proceedings of the fourth international € conference on Fomes annosus. September 17-22, € 1973; Athens, Georgia. Southeastern Forest € Experiment Station. U.S. Department of € Agriculture, Forest Service; 8-15. €

Dubreuil, S.H.; Tunnock, S.; Dooling, O.J. € 1982. Bark beetle history and root disease € on the Hungry Horse District, Flathead € National Forest. Report 82-12. Missoula, € Mont.: Cooperative Forestry and Pest € Management Report 82-12., U.S. Department of € Agriculture, Forest Service; 11 p. €

Ehrlich, J. 1939. A preliminary study of root € diseases in western white pine. Paper No. 1, € Missoula, Mont.: Northern Rocky Mountain € Forest and Range Experiment Station, U.S. € Department of Agriculture, Forest Service; 10 € P. €

Franklin, J.F.; Cromack, K., Jr.; Denison, W.; Mckee, A.; Maser, C.; Sedell, J.; Swanson, F.; Juday, G. 1981. Ecological characteristics of old-growth Douglas-fir forests. Report PNW-118. Corvallis, Ore.: Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service; 48 p.

Hagle, S., Forest Pathologist, Northern Region, Cooperative Forestry and Pest Management, U.S. Department of Agriculture, Forest Service, Missoula, Mont. (Telephone conversation and computer communications with R. Williams) February, 1989.

James, R.L., Stewart C.A.; Williams, R.E. 1984. Estimating root disease losses in northern Rocky Mountain National Forests. Canadian Journal of Forest Research 14: 652-655.

Jurgenson, M.F., Larson, J.J.; Harvey, A.E. 1977. Effects of timber harvesting on soil biology. In: Proceedings of the Society of American Foresters 1977 National Convention, October 2-6, 1977. Albuquerque, N.M. Society of American Foresters: Washington, D.C.; 244-250.

Knapp, K.A.; Weatherby, J.; Hoffman, J.; Kalve, V; LaMadeleine, L. 1989. Forest insect and disease conditions: Intermountain region--1988. Ogden, Ut.: Intermountain Region, Forest Pest Management, U.S. Department of Agriculture, Forest Service; 35 P.

Knopf, J.A.E. 1980. Forest insect and disease conditions: Intermountain Region--1980. Ogden, Ut.: Intermountain Region, Forest Pest Management, U.S. Department of Agriculture, Forest Service; 14 p.

Koenigs, J.W. 1969. Root rot and chlorosis of released and thinned western redcedar. Journal of Forestry 67: 312-315.

Livingston, R.L; and others. 1988. Idaho Forest Pest Conditions and Program Summary 1987. State of Idaho, Dept. of Lands Report No. 88-1; 28 p.

Marshall, J.P.; Hoffman, J.T. 1983. Evaluation of longevity and spread of annosus root rot in the BLM's Idaho City ponderosa pine tree improvement plantation. Report No. 83-13. Ogden, Ut.: Intermountain Region, Forest Pest Management, U.S. Department of Agriculture, Forest Service; 7 p.

Miller, D.L.; Partridge, A.D. 1973. Fungus associations in root rots of grand fir. Plant Disease Reporter 57: 346-348.

Mills, L.J.; Russell, K. 1981. Detection and correction of hazard trees in Washington's recreation areas: A how-to guide for recreation site managers. Report No. 42. Olympia, Wash.: Washington State Dept. of Natural Resources; 37 p.

Paine, L.A. 1971. Accident hazard: evaluation and control decisions on forested recreation sites. Research Paper PSW-68. San Francisco, Calif.: Pacific Southwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service; 10 p.

Partridge, A.D., Professor, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, Idaho [Telephone conversation with R. Williams, 2/89].

Partridge, A.D.; Canfield, E.R. 1978. A report regarding mortality of Douglas-fir in the Boise National Forest. Moscow, Id.: University of Idaho, College of Forestry, Wildlife and Range Sciences; 9 p.

Partridge, A.D.; Miller, D.L. 1972. Bark beetles and root rots related in Idaho conifers. Plant Disease Reporter 56: 498-500.

Tegethoff, A.C. 1973. Known distribution of Fomes annosus in the Intermountain Region. Plant Disease Reporter 57: 407-410.

Tkacz, B.M. 1983. An evaluation of disease and insect conditions in a spruce-fir stand on the Beaver Ranger District, Fishlake National Forest. Report R-4-83-7; Ogden, Ut.: Intermountain Region, Forest Pest Management Report; U.S. Department of Agriculture, Forest Service; 12 p.

Wagener, W.W. 1963. Judging hazard from native trees in California recreational areas--A guide for professional foresters. Research Paper-Pl. Berkeley, Calif.: Pacific Southwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service; 29 P.

Williams, R.E.; Leaphart, C.D. 1978. A system using aerial photography to estimate area of root disease centers in forests. Canadian Journal of Forest Research 8: 214-219.

Williams, R.E.; Haglund, S. 1976. Fomes annosus in roots of mature ponderosa pine in western Montana. Plant Disease Reporter 60: 101-103.