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Annosus root disease in pre-commercially thinned stands in coastal British Columbia

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Figure 1. Annosus root disease may spread from colonized stumps to healthy trees at root contacts.

Strategic Importance

Heterobasidion annosum, the fungus that causes Annosus root disease, is endemic in many temperate zone forests where it causes mortality and butt rot of coniferous and occasionally of broadleaved species. Incidence of the root disease and the damage it causes in managed stands are related to the frequency and intensity of thinnings. The fungus infects freshly cut stumps by means of airborne spores. After infection, it may colonize the stump, grow into its roots and spread to adjacent healthy trees at root contacts (Figure 1).

Two varieties of the fungus, an S-type and a P-type, have been found in western North America. Only the S-type has been detected in coastal British Columbia (B.C.), where its range is coincident with that of western hemlock. In coastal old-growth forests *H. annosum* causes butt rot (Figure 2). In second growth, trees less than 15 years old whose roots contact *H. annosum* inoculum in old-growth residues may be killed. Older trees with decayed roots may be windthrown or butt rotted. Except for those of red and yellow cedar, stumps of all commercial coniferous species are susceptible to infection by *H. annosum* spores.

Detection and Recognition

Annosus root disease is difficult to detect because diseased trees rarely show above-ground signs or symptoms. However, young trees with advanced infection show reduced leader growth, chlorotic foliage, and often a distress cone crop. In stands 30 years old and older, espe-

Figure 2. Stump of a windthrown western hemlock with butt rot.

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cially those with a large hemlock component, one or more windthrown trees with decayed roots may indicate an Annosus root disease center. The early stage of *H. annosum* decay is a yellow-brown to red-brown stain, while in advanced stages decay is stringy to spongy, with numerous small black flecks running parallel to the grain. Cream-coloured mycelial pustules, 2-4 mm in diameter, are frequently present on the surface of decayed roots. The presence of *H. annosum* in a decay sample can be confirmed by wrapping it in moist paper and incubating it in a plastic bag at room temperature for 5-6 days. The characteristic asexual fruiting structures can be seen with a hand lens or dissecting microscope on the surface of decayed wood (Figure 3).

Figure 3. Asexual fruiting structures will form on the wood surfaces.

Conks are occasionally found on old-growth stumps and on the underside of the decayed roots and stem of windthrown trees. Conks are perennial and woody, and vary in shape from flat to bracket-like; their upper surface is dark brown to black and the lower surface is white to cream, with small pores.

Damage

Young trees that become infected are occasionally killed, and trees with decayed roots are predisposed to windthrow. However, decay of the lower bole accounts for most of the damage caused by Annosus root disease. Incidence of trees with butt rot can be as high as 10%, and decay can extend several meters up the stem.

Factors affecting spore infection of stumps following spacing

The effects of tree species, stump diameter, tree age at thinning, season of thinning and biogeoclimatic subzone on incidence of spore infection of stumps by *H. annosum* were studied in 83 spaced (precommercially thinned) stands throughout coastal B.C. Spaced stumps infected by spores of *H. annosum* were found in 74 of the 83 stands sampled, indicating that the fungus is widely distributed in coastal B.C. and that air-borne spores are present throughout the year.

Species of stump

In increasing order, the susceptibility of stumps to spore infection was Douglas-fir, western hemlock, Sitka spruce and amabilis fir (Table 1). The percentage of surface area colonized in stumps of hemlock, Sitka spruce and amabilis fir was significantly greater than in Douglas-fir stumps. Also, about 70% of the hemlock, Sitka spruce and amabilis fir stumps that were colonized had 10% or more surface area colonized while less than half the Douglas-fir stumps were similarly colonized.

Stump diameter

Stump diameter had strongly positive effects on incidence of colonized stumps and surface area colonized (Figure 4).

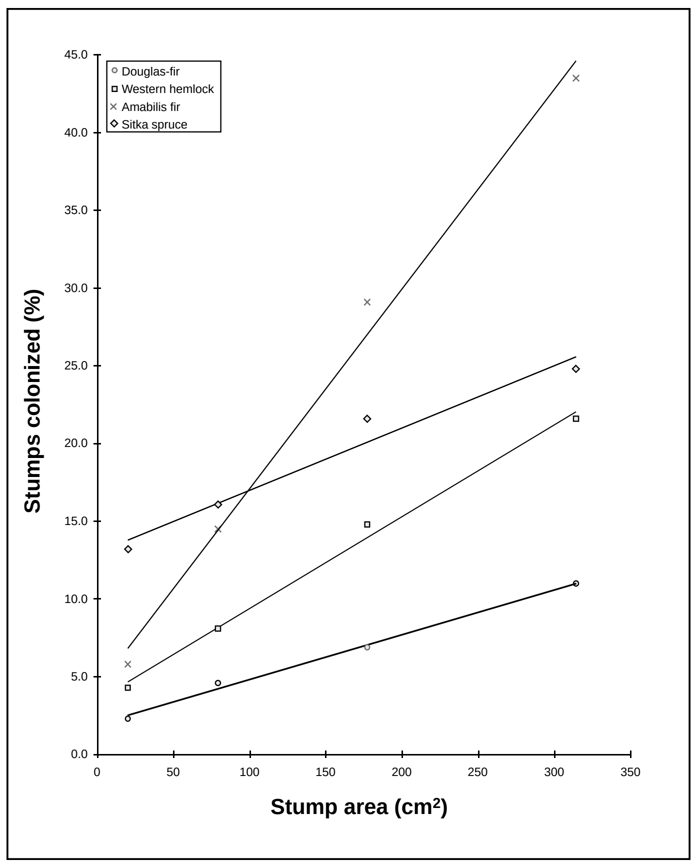

Figure 4. Percentage of Douglas-fir, western hemlock, Sitka spruce, and amabilis fir stumps colonized by* Heterobasidion annosum *plotted against the surface area of 5–20-cm diameter stumps.

Tree age at thinning

For Douglas-fir, western hemlock and amabilis fir there was a sharp increase in the incidence of colonized stumps for those more than 15 years old when cut compared to those less than 15 years old when cut. The increase in incidence was greater than the proportional increase in susceptible stump area.

Season of thinning

Differences among seasons in incidence of stump infection and surface area colonized were not significant. However, for each species there are seasonal patterns that are identical for both incidence and area colonized. The maximum values occurred in the summer for Douglas-fir, western hemlock, and Sitka spruce and in the autumn for amabilis fir. The minimum values occurred in the spring for Douglas-fir and amabilis fir, in the winter for Sitka spruce and in the autumn and winter for western hemlock. There was little difference among values for two or three seasons for Douglas-fir, western hemlock and Sitka spruce. Amabilis fir showed the most seasonal variation and Douglas-fir the least.

Biogeoclimatic subzone

As was the case with season of thinning, differences in incidence and surface area colonized due to biogeoclimatic subzone were not significant. Trends are evident in values for the incidence and especially for area colonized for Douglas-fir and western hemlock. The area colonized on Douglas-fir and amabilis fir stumps increased with increasing precipitation while the incidence and area colonized on western hemlock stumps decreased.

How do these factors affect stump infection and colonization?

Stumps of amabilis fir, Sitka spruce and western hemlock are clearly more susceptible to colonization than those of Douglas-fir. Only the sapwood of Douglas-fir stumps can be colonized, whereas the entire surface of the other species is susceptible. The smaller target presented by Douglas-fir stumps may account, in part, for the lower incidence and area colonized.

Small-diameter stumps present a smaller target for spores than large-diameter stumps. Also, because stumps of different diameter were the same age at a site, growth rings were narrow on the small stumps; research elsewhere showed that stumps with narrow rings were less susceptible than those with wide rings. Target size and ring width appear to account for the effect of stump diameter.

Redfern (1993) determined that there is an optimal range of moisture content for infection of stump wood by *H. annosum*; by raising the moisture content of stump wood, precipitation appeared to increase or decrease infection. Precipitation may also reduce the long-term survival of the fungus in stumps by raising the moisture content to near saturation. Both the seasonal pattern and the pattern across biogeoclimatic subzones for incidence of *H. annosum* in stumps and area colonized on Douglas-fir, western hemlock and amabilis fir could be influenced by the amount and seasonal distribution of precipitation. These species occurred in two or more subzones and they responded differently to increasing precipitation with both incidence and colonized area tending to decrease for hemlock and increase for Douglas-fir and amabilis fir.

Table 1. Number of stands sampled containing Douglas-fir, western hemlock, amabilis fir and Sitka spruce, the percentage of all stumps and those with more than 10% of their surface area colonized by* Heterobasidion annosum*, and the percentage of stump surface area colonized for all stumps and for colonized stumps.

Species	Number of stands	Number of stumps sampled	Stumps colonized %		Surface area colonized %	
			All	> 10% area	All	Colonized
Douglas-fir	38	2900	5.9	2.7	1.6	16.0
Hemlock	75	5750	9.8	7.0	4.3	27.7
Amabilis fir	25	1950	19.2	15.8	8.6	32.7
Sitka spruce	11	950	19.6	12.7	11.3	32.3

Management implications for spacing juvenile stands

Nearly all coastal stands, including juvenile stands, have trees infected by *H. annosum*, and have sources of *H. annosum* spores. Infection and colonization of spacing stumps adds to the pool of *H. annosum* inoculum on the sites. This new inoculum may increase the incidence of butt rot in crop trees. The amount of new inoculum in Douglas-fir stumps is small and may be of little consequence in contrast to that in Sitka spruce and amabilis fir stumps.

Increases in inoculum can be minimized by:

- Thinning before age 15,
- Cutting only trees less than 10 cm in diameter, and
- Thinning during low risk seasons.

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For additional information on the Canadian Forest Service and these studies visit our web site at:
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Additional Reading

Morrison, D.J.; Johnson, A.L.S. 1999. Incidence of *Heterobasidium annosum* in precommercial thinning stumps in coastal British Columbia. European Journal of Forest Pathology 29: 1-16.

Morrison, D.J.; Johnson, A.L.S. 1970: Seasonal variation of stump infection by *Fomes annosus* in coastal British Columbia. Forestry Chronicle 46: 200-202.

Morrison, D. J.; Johnson, A. L. S. 1978. Stump colonization and spread of *Fomes annosus* 5 years after thinning. Canadian Journal of Forest Research 8:177-180.

Morrison, D.J.; Larock, M.D.; Waters, A.J., 1986: Stump infection by *Fomes annosus* in spaced stands in the Prince Rupert Forest Region of British Columbia. Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-285. 12 p .

Otrosina, W. J.: Scharpf, R. F. (technical coordinators). 1989. Proc. Symp. on research and management of annosus root disease (*Heterobasidion annosum*) in western North America. USDA Forest Service, General Technical Report PSW 116.

Redfern, D. B. 1993: The effect of wood moisture on infection of Sitka spruce stumps by basidiospores of *Heterobasidion annosum*. European Journal of Forest Pathology 23: 218-235.

Reynolds, G.; Wallis, G.W. 1966: Seasonal variation in spore deposition of *Fomes annosus* in coastal forests of British Columbia. Can. Dept. For., Bi-monthly Res. Notes 2(4): 6-7.

Shaw, C.G.III, 1981: Infection of western hemlock and Sitka spruce thinning stumps by *Fomes annosus* and *Armillaria mellea* in southeast Alaska. Plant Disease 65: 967-971.

Wallis, G.W.; Reynolds, G., 1970: *Fomes annosus* root and butt rot: A threat in coastal British Columbia. Forestry Chronicle 46: 221-224.

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