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Heart Rots of Douglas-Fir

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Nearly one-fourth of the sawtimber cut in continental United States is Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). In many Douglas-fir stands, and especially in overmature stands in western Oregon and Washington, heart rots have damaged or destroyed large volumes of otherwise valuable timber. By far the most common of these heart rots are conk rot (caused by *Fomes pini* (Fr.) Karst.), red-brown butt rot (*Polyporus schweinitzii* Fr.), brown trunk rot (*F. officinalis* (Fr.) Faull), and yellow-brown top rot (*F. subroseus* (Weir) Overh.).

Heart-Rot Estimates by Cruisers

The amount of volume loss associated with external indicators of decay, such as sporophores and wounds, varies from tree to tree and from one locality to another. Good estimates of net volumes can usually be made only by cruisers with local experience. Cruisers can increase their accuracy by observing decay extent in felled and bucked trees, by comparing their estimates with gross and net scales, and by watching heart-rotted logs as they are opened at the mill.

Local experience is probably most helpful in estimating loss from conk rot. Unlike the brown rots, conk rot does not seriously reduce wood strength until decay has become fairly well developed. Rules given on the following pages for estimating extent of conk-rot cull represent average practices and may require modification to conform to local market requirements.

Conk Rot

Occurrence

In 1953, the volume of Douglas-fir sawtimber on commercial forest land in the Douglas-fir subregion of the Pacific Northwest was estimated to be 215 billion board feet in trees 31 inches d.b.h. and larger. Much of this volume is in overmature stands in which approximately 17 percent is decayed. Conk rot, or red ring rot, constitutes more than three-fourths of the total heart-rot cull in Douglas-fir. It is usually more prevalent on southerly aspects, on good sites, in pure stands, on steep and upper slopes, and on shallow soils.

Description of Rot

The early or incipient stage of decay is red to olive purple, or occasionally brown, fading gradually at its margins into the red, orange, or yellow of sound heartwood. Wood at this stage of decay is reduced little, if any, in usefulness since it retains most of its original strength and since conk rot makes no further progress after the lumber has been cut.

In the advanced or typical stage, color is deeper and the wood is more or less riddled with spindle-shaped, slightly pointed, white pockets running with the grain and separated by firm wood. These pockets are usually filled with a white, loose

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mass of cellulose. Several pockets may merge to form a cavity of irregular shape. When seen on the cross section at the end of a log, the pockets may be scattered fairly uniformly throughout the heartwood or may be in the form of continuous or interrupted rings. Wood with sparsely distributed white pockets is useful for many purposes since it usually retains more than 80 percent of its original strength. Some wood with moderately abundant pockets is used for decorative panels. Wood with coalescing pockets is usually culled. Conk rot may attack any part of the trunk but is found more frequently in intermediate parts than in butts or tops.

Decay Indicators

Conks (sporophores) of the fungus are perennial, usually about the size of a man's fist, hoof shaped on old trees but thinner on young ones, corky, gray brown to olive below, with irregular pores, rough and concentrically furrowed, and dark brown to black on top (fig. 1). Their lower margins are often velvety and golden brown. In some localities, conks are common even on trees containing only the early stages of decay. Conks may occur anywhere on the bole; however, on old trees infected late in life they are often restricted to the upper part of the trunk, where they are hard to see. Sometimes, in old stands, large conks fall from the trunks and small conks become covered with moss, so that no indicators may be visible even though the trees are highly defective.

Conks on trees less than about 125 years old do not necessarily indicate much if any reduction in value, since white pockets are usually sparse in infected young trees. In older trees west of the Cascade Range in Oregon and Washington, and under favorable conditions for observation, linear extent of cull can be estimated fairly accurately from size and location of conks (fig. 2). In a 200-year-old tree, for example, cull will usually extend about 10 feet above the highest and below the lowest conks; in a 400-year-old tree, cull will usually extend about 25 feet beyond conks. Cull is usually more extensive where conks are larger than average and less extensive where conks are

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FIGURE 1.—Sporophore or conk of *Fomes pini* from old-growth Douglas-fir.

smaller. These estimates include only the typical white pocket rot; incipient decay ordinarily extends 3 or 4 feet beyond the typical stage.

In cruising Douglas-fir stands over 125 years old, allowance must be made for "hidden cull"; that is, for trees that have no apparent conks but that contain a significant amount of decay. This lack of visible conks on infected trees may occur because the conks have fallen off, or because they are hidden from view by moss or foliage. Expert timber cruisers allow for hidden cull on the basis of their experience.

Swollen or "punk" knots are less conspicuous than conks, but are fairly dependable as decay indicators. They are best seen in profile, where they appear as slight bulges,

FIGURE 2.—*Fomes pini* conks on a living Douglas-fir.

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FIGURE 3.—Swollen knots caused by *Fomes pini* on a Douglas-fir.

often gently rounded and rarely protruding at an angle greater than 30° from the main line of the trunk (figs. 3, 4, 5). Decay generally extends only about half as far beyond swollen knots as beyond conks. Swollen knots can be readily distinguished from burls, which project more abruptly from the trunk and which do not indicate decay.

Minimizing Loss

Hasty liquidation of Douglas-fir stands is of little benefit in reducing conk-rot loss. Annual rot increment, even in old-growth stands, seldom exceeds one-third of 1 percent of the gross volume, and is more than counterbalanced, until fairly late in the life of the stand,

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FIGURE 4.—Detail of swollen knot caused by *Fomes pini* on Douglas-fir. Bark removed to expose knot.

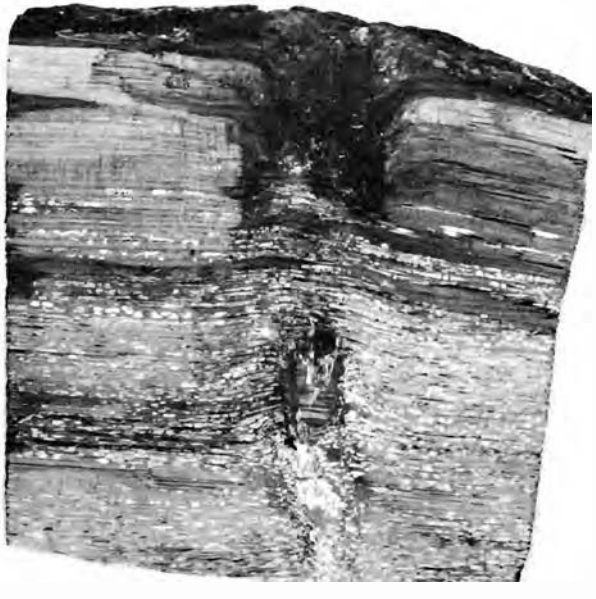

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FIGURE 5.—Radial section of Douglas-fir showing a swollen or "punk" knot at the top, incipient *Fomes pini* decay in the outer heartwood, and advanced decay in the inner heartwood.

by gross increment. In fact, there appear to be periods when decay volume in living trees in old-growth stands is actually decreasing as badly decayed trees are suppressed and killed by competition from their healthier neighbors.

In defective old-growth timber, both sound volume left in cull logs and cull volume handled in merchantable logs can be decreased by bucking at the ends of the cull column, as indicated by conks and swollen knots.

Under intensive management, young-growth Douglas-fir stands will ordinarily be harvested before conk rot becomes serious, and losses can be further reduced by removing infected trees during improvement cuttings.

Other Heart Rots

Red-Brown Butt Rot

Red-brown butt rot is most damaging in old, fire-scarred trees. In young stands, where it is sometimes fairly common, most infections occur through the roots, and butt scars are of little value as external indicators. In trees of all ages, infected wood is weak and worthless, even during early stages of decay. Damage from red-brown butt rot often culminates in breakage of badly infected trees during storms.

The first evidence of incipient decay is a faint yellow or brown discoloration. The wood is still firm at this time but has already lost much of its strength. The discoloration gradually intensifies as the decay progresses. This incipient stage usually extends only about 2 feet, but sometimes more than 8 feet, beyond the typical stage. In the advanced or typical stage (fig. 6), the decayed wood is brown to red brown, tends to separate into rectangular pieces, and crushes to a smooth powder between the fingers. Thin layers of fungus tissue occur in many of the crevices. Decay is typically confined to the roots and the first 16-foot log.

Conks are annual and are seldom found in abundance. They appear most commonly on the ground above decayed roots (fig. 7) or directly on trees along the margins of old butt scars. On the ground, the conk is circular in shape when viewed from above, is sunken in the center, and

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FIGURE 6.—Red-brown butt rot caused by *Polyporus schweinitzii*.

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FIGURE 7.—Conks of the velvet-top fungus (*Polyporus schweinitzii*) on the ground near the base of an infected Douglas-fir.

tapers below to a short, thick stalk. On the tree, the conk is bracket shaped and frequently consists of two or more brackets growing together, one above another. Conks usually appear soon after the first fall rains. Mature conks are usually from 6 to 10 inches in diameter. When fresh, the upper surface is velvety, concentrically zoned, and reddish brown with a light yellow-brown margin. The undersurface, consisting of irregular pores, is dirty green but turns red brown when bruised. The substance of the conk is moist and cheesy. Old conks are deep red brown to black and corky or crumbly when dry.

Where a conk or a healed butt scar is present on old-growth timber, the trunk is often cull to about 12 feet above the ground. Where the limits of the scar are plainly visible, cull may be estimated to extend about 2 feet above the top of the scar. The decay column is usually conical in shape, narrowing from the butt. In felled timber, the linear extent of the rot column can be estimated at about 10 inches up the log for each inch of diameter of the roughly circular rot area on the butt cut. These rules are not necessarily accurate for individual instances: they give good results only when applied to large numbers of trees or logs.

Brown Trunk Rot

Brown trunk rot is of little importance in young mature stands, but sometimes causes heavy loss in very old ones. Although much less common than conk rot, it is much more damaging to individual trees.

Incipient rot can first be detected as a faint brown or, rarely, an intense purple discoloration which is preceded by a hidden stage extending for several inches beyond the last visible discoloration. As the rot progresses, the brown discoloration darkens or the purple fades, and the wood becomes softer. Wood is seriously weakened, even in the hidden stage of the rot, and is not suitable for use. In the advanced stage, the wood is brown, crumbly, and frequently has conspicuous mycelial felts in shrinkage cracks (fig. 8).

Fomes officinalis produces large, chalky, perennial conks (fig. 9) which are not common on living trees. They may be roughly hoof shaped or long and narrow. The substance of the conk is white, soft, and cheesy when young, and corky

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FIGURE 8.—Advanced stage of brown trunk rot, caused by *Fomes officinalis*, in Douglas-fir heartwood. Note mycelial felts.

or rather crumbly when old and dry. The undersurface is gray brown to almost white and has small pores. The conks form at knots or old wounds.

The amount of brown trunk rot in standing timber can seldom be estimated accurately. Conks form only occasionally and usually not until decay has become so extensive that the tree is almost or completely unmerchantable. Broken-top trees are frequently infected and should be closely scrutinized for indications of rot. Stubs of large, broken branches with decayed heartwood usually indicate extensive decay in the trunk.

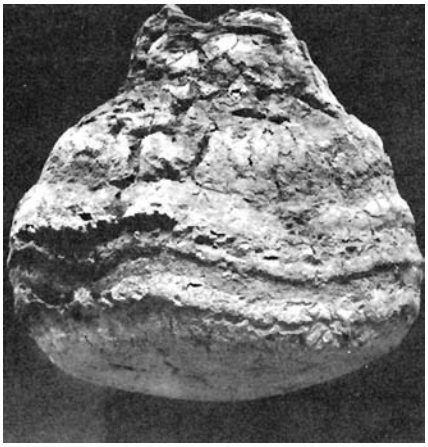

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FIGURE. 9—A hoof-shaped sporophore of the quinine fungus, *Fomes officinalis*.

Yellow-Brown Top Rot

Yellow-brown top rot is the most common heart rot in young-growth Douglas-fir and is not uncommon in old-growth timber. However, it usually occurs in the tops, where values are low, so that losses are seldom great. It is most damaging in stands where sleetstorms have broken many tops, thereby providing infection courts. In such stands, the decay is frequently the indirect cause of tree mortality. The decay extends rapidly down the trunk and so weakens it that top breakage again occurs, this time below the base of the crown.

The sporophores are perennial, bracketlike, and range up to 6 inches in width. The undersurface is a delicate rose color and has small regular pores. The upper surface is hard, rough, zoned, and black (fig. 10).

The first indication of the rot is a faint brown or yellowish-brown discoloration, the outer limit of which is sometimes marked by a zone of bluish green. As decay progresses, the yellow brown deepens, the green fades, and the wood softens. Advanced decay is a yellowish-brown crumbly rot. Wood in any decay stage is worthless.

Yellow-brown top rot is easily overlooked in standing timber unless trees are carefully examined for broken and spike tops, which are

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FIGURE 10.—Cross section of a decayed top from a living Douglas-fir, showing yellow-brown top rot (caused by *Fomes subroseus*) and the upper surface of a conk.

fairly reliable decay indicators if the original trunk was more than 3 or 4 inches in diameter at the point of breakage. Although conks are common, they are so high in the trees as to be easily missed and are often completely hidden by branches. Infected trees should be removed during thinnings or partial cuttings.

Pruning and Heart-Rot Hazard

Pruning young-growth Douglas-fir for quality increment does not appreciably increase the hazard of heart-rot infection. Moreover, even this slight risk can be minimized by pruning in the fall and by pruning dead and low-vigor branches only. Although slight injuries to the trunk cambium at the branch base appear to hasten occlusion of the cut branch base, extensive cambial injury may delay healing long enough for heart-rot infection to become established.

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