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Heart Rots of Red and White Firs

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Heart rots, caused by fungi that attack the heartwood of living trees, are responsible for the greatest volume loss sustained by California red fir (*Abies magnifica* A. Murr.) and white fir (*A. concolor* (Gord. and Glend.) Lindl.). These two firs comprise 25 percent of the commercial timber of California. More than 13 percent of the volume in these firs is useless cull because of heart rots. In red fir this loss amounts to about 10 percent and in white fir about 15 percent of the gross merchantable volume. Thrifty, uninjured young fir trees are generally free from heart rots, but old overmature trees are frequently so badly decayed they are worthless for lumber manufacture.

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Types

Brown rot and white rot are the two general types of wood decay caused by fungi.

Brown rot results from the action of fungi which destroy the cellulose and leave a dry, brown, crumbly mass of lignin constituents of wood (fig. 1). Wood containing brown rot, even in the earliest visible stages of decay, is so weakened that it will fail in use and must be

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Figure 1.—Brown cubical rot caused by the sulfur fungus in red fir.

discarded. Since the cellulose fibers are affected, the value of wood for pulp is lost when brown rot occurs.

White rot is caused by fungi that destroy both lignin and cellulose. These fungi leave a more or less fibrous or stringy residue which may be white, tan, or brownish (fig. 2). As the decay progresses, affected wood often is reduced to a wet pulpy mass. Later this wood may be completely destroyed, leaving a hollow in the tree. Pulp yields from wood containing white rot are reduced, but pulp quality is not greatly affected.

Occurrence

White rots make up about four-fifths of the decay loss in red and white fir. In descending order of occurrence, the four major white rots are:

Name	*Causal fungus*
Mottled rot	Yellow cap fungus (*Pholiota adiposa* (Fr.) Quel.)
White spongy rot	Fomes root fungus (*Fomes annosus* (Fr.) Cke.)
Stringy rot	Indian paint fungus (*Echinodontium tinctorium* Ell. & Ev.)
Soft spongy rot	Shoestring fungus (*Armillaria mellea* (Fr.) Quel.)

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Figure 2.—White rot caused by the yellow cap fungus in red fir.

About half of the white rot is caused by the yellow cap fungus. In some localities, however, the greatest proportion of rot in old-growth fir is caused by the Indian paint fungus.

Brown cubical rots cause the other one-fifth of the decay loss in the firs. In descending order of occurrence and importance, the three major brown rots are:

Name	*Causal fungus*
Brown crumbly rot	Red belt fungus (*Fomes pinicola* (Fr.) Cke.)
Brown cubical rot	Sulfur fungus (*Polyporus sulphureus* Fr.)
Red-brown butt rot	Velvet top fungus (*Polyporus schweinitzii* Fr.)

More than half of the brown rot is caused by the red belt fungus, which attacks both red and white fir. The sulfur fungus and the velvet top fungus cause appreciable loss in red fir but rarely are found in white fir.

Several other fungi cause heart rot in these firs, but their occurrence is sporadic and only of local importance. In white fir, these less common fungi include *Polyporus dryadeus* Fr., *Fomes officinalis* (Vill. ex Fr.) Faull, or *F. pini* (Thore) Lloyd; in red fir, *Ganoderma* sp.

Location in the Tree

Under suitable conditions of moisture and temperature, spores from the fruiting bodies (conks) of these fungi infect heartwood through breaks or wounds in the sapwood or through branch stubs. Some rots are most prevalent in the roots and lower trunk. Others occur in the upper trunk. A third group may occur anywhere in the tree.

The shoestring fungus and the velvet top fungus usually enter through dead or wounded roots and cause rot in the roots and lower trunk. The red belt fungus usually enters dead or broken tops; hence, the rot is most prevalent in the upper bole of trees. The Indian paint fungus enters through branch stubs containing heartwood. The rot it causes is therefore most common in the midtrunk region, but it may extend down to the lower trunk or up into the top. The yellow cap fungus and the sulfur fungus enter through fire scars or other basal wounds, and the resultant rots occur in the lower bole; however, they usually extend up the trunk, sometimes to 50 or 60 feet above the ground. The fomes root fungus enters through wounds anywhere, and the rot column may extend from the roots to the upper trunk.

Fire wounds are the most important entry points for heart rot fungi. Dwarfmistletoe cankers are common entry points. Those in the lower bole usually admit the yellow cap fungus. Those in the upper bole often admit the red belt fungus, especially when the tree top is killed by the canker. Frost cracks and lightning wounds also are entry points.

Indicators

Fire scars (fig. 3) are the most common indicators of the presence of heart rot in living trees. Dead and broken tops, dwarfmistletoe cankers, frost cracks, or other wounds exposing the heartwood also are good indicators. Conks of the Indian paint fungus on a tree indicate that it contains heart rot (fig. 4). The number, distribution, and vertical spacing of these conks provide a means of estimating the extent of decay. Indian paint fungus is the only fungus of consequence that enters the trunk through branch stubs. But trees without visible indicators may contain decay. Dead or injured roots, for example, are not easily seen and hence are not useful indicators, but

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Figure 3.—Old fire scar, the most common indicator of heart rot in true firs.

they too can be entry points for decay fungi.

Studies of cull associated with various external indicators on red and white fir in California have provided foresters with tables for estimating the percentage of cull volume in these trees. The tables were published in two reports (see references) by the California (now Pacific Southwest) Forest and Range Experiment Station.

Minimizing Future Losses

As virgin fir forests are converted to managed young-growth stands, the total volume of cull from heart rot can be expected to decrease. The rotation age of these managed young-growth fir stands will be less than the age at which heart rots ordinarily cause appreciable damage. But heart rots must be prevented from gaining early entrance into these young trees if serious decay losses are to be avoided.

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Figure 4.—Conk of the Indian paint fungus showing the characteristic toothed under surface. A branch stub is the typical infection site.

Heart rot losses in future stands may be minimized by reducing mechanical injuries and by preventing fires, particularly ground fires which produce wounds at the base of tree trunks. The wood of true firs does not contain resin. Without this natural protection, exposed wood is highly susceptible to infection by wood-decaying fungi. In managed forests, infection by the Indian paint fungus may be reduced by maintaining fully stocked stands, thereby encouraging natural pruning before branches get old enough to contain appreciable heartwood.

Intermediate cuts should remove all decadent trees as well as those with broken tops, sizable wounds, or conks. In felling and logging, special care should be taken to prevent breaking the tops or otherwise wounding trees in the residual stand. Root and trunk wounds can be reduced by properly locating skid trails and by keeping the logging tractors on these trails. If seed trees bearing conks are retained in old-growth stands, they should be left only long enough to insure establishment of a satisfactory new stand. Fungi fruiting on infected trees do not always produce conspicuous conks. Nevertheless, they do produce spores that constitute a threat to other trees in the stand; therefore, early cutting of all decadent, overmature trees is a worthwhile sanitation measure.

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