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Forest Health Protection and State Forestry Organizations

Management Guide for

Stem Decays

Decays may be classed as sap rots or heart rots, depending on the fungus involved and the part of the tree affected. Many decays are restricted to a few principal tree species, all native trees are subject to decay by one or more fungi.

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Key Points

- The type of decay produced is determined by the fungus involved.
- Younger trees are practically free from decay, but the likelihood of occurrence of decay and the amount of decay increases with age.
- Once a tree dies, decay may advance throughout the tree.

Damage

Stem and butt decay fungi enter living trees through trunk wounds, dead twigs, broken branches and tops, or wounded roots. The fungi develop within the tree, often with no external signs of defect. They may eventually produce fruiting bodies that produce spores capable of spreading the decay to other trees. In old-growth stands, these decay fungi cause more volume loss than all other diseases combined.

Two types of decay occur, depending on how physical and chemical properties of wood are altered. Brown rots destroy cellulose, leaving the brown lignin that usually cracks into cubical blocks; white rots destroy both cellulose and lignin, leaving only a bleached residue in late stages of decay. The type of decay produced is determined by the fungus involved.

Life History

Two stages describe the degree of wood decay. In the earliest or incipient stage, the predominant feature is discoloration or stain without an accompanying strength loss; the advanced stage is characterized by both cell breakdown and strength loss. Occasionally, an intermediate stage occurs between the two stages. All stages are often present in a tree, the incipient stage at the advancing margins of a zone of decay, and the more advanced stages near the center.

Decays may be classed as sap rots or heart rots, depending on the fungus involved and the part of the tree affected. Usually sap rots are limited to the sapwood, while heart rots are found only in the heartwood. For some decay fungi, though, they may cross the boundary. Also, once a tree dies, decay may advance throughout the tree.

Figure 1, Phellinus pini conk on western larch. USDA, Forest Service, Northern Region Forest Health Protection photo files.

Identification

Most decay fungi produce one of two types of reproductive structures, either a mushroom or a conk. Mushrooms are fleshy and ephemeral, lasting less than a single season. Conks are harder and more woody (Fig 1). They may be annual or perennial, but usually are evident more than a single season. Absence of fruiting bodies does not mean that a tree is without decay. Some fungi rarely produce conks on living trees, although fruiting may be prolific after the tree dies. Presence of conks on some trees is a reliable indicator of the amount of cull, or volume reduction, to be expected. These cull factors are included in Table 1.

Although many decays are restricted to a few principal tree species, all native trees are subject to decay by one or more fungi. Hosts for the more common and significant decay fungi in Region 1 are shown in Table 1.

Table 1. Common decays in the Northern and Intermountain Regions.

SCIENTIFIC - COMMON NAME	HOSTS	INCIPIENT DECAY	ADVANCED DECAY	SPOROPHORE	CULL INDICATORS
Echinodontium tinctorium (Ell. & Ev.) Ell. & Ev. Indian paint fungus	Heartwood of true firs and hemlock.	Slightly darkened, light brown or tan water-soaked spots or larger areas.	Wood tan to reddish, soft and stringy, often brown to red zone lines; reddish, stringy.	Large, woody, hoof-shaped. Upper surface black, roughly cracked. Lower surface with hard gray teeth. Conk brick red inside. Often below branch stubs or knots.	3-4 punk knots or 2-3 scattered conks indicate extensive cull. 1 conk indicates 16' decay in either direction.
Phellinus pini (Thore.: Fr.) A. Ames Red ring rot	Heartwood of most living conifers. Most common in larch, pines, spruce, and Douglas-fir.	Wood reddish to purplish.	Pockets white, spindle-shaped, well-defined, separated by firm red wood. Black lines termed "zone lines" may be present.	Conk about 3" diameter, shelving, shape variable. Top: dark, concentric furrows. Underside: pores yellow-brown.	2-3' up and 3-5' down from each punk knot, swollen knot or conk; 100% cull if several present
Dichomitus squalens (Karst.) Reid Red ray rot	Heartwood of living conifers, particularly ponderosa pine. Also an important decayer of slash.	Reddish to purplish color in radial or circular pattern (easily confused with *P. pini*)	Pockets white, elongate, with square ends; margins not well defined, run together. Wood eventually crumbles. No zone lines. Black flecks may be present in pockets.	Conk white, crust-like, with pores, on underside of logs.	Sporophores on logs or dead branches of living trees indicate extensive cull. Difficult to detect in living trees since sporophores rare. Length of decay column variable.
Phellinus weirii (Murr.) Gilbn. Laminated butt rot (Laminated root rot)	Butt and root rot in Douglas-fir, grand fir, and hemlock. Stem rot in cedar.	Yellowish-brownish discolored areas.	Yellow-brown flaky, riddled with tiny pockets, delaminates easily along annual rings; some traces of brown fungal tissue present.	Extremely rare; brown crust-like on underside of logs or exposed roots.	Sporophores indicate 6-12' in Douglas-fir, grand fir, and hemlock. 8' or more in cedar. Basal wounds indicate probable cull in stands where the fungus is known to be present.

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Table 1. Common decays in the Northern and Intermountain Regions.

(Continued from page 2)

SCIENTIFIC - COMMON NAME	HOSTS	INCIPIENT DECAY	ADVANCED DECAY	SPOROPHORE	CULL INDICATORS
Postia sericeomollis (Rom.) Julich Brown pocket rot of cedar	Western red cedar.	Yellow-brown elongate areas.	Large pockets develop containing brown cubical rot; pockets unite to form solid mass of decay; some white fungal tissue present.	Very rare on live trees; white crust-like patches with pores.	Too irregular of column; assume cylinder.
Fomitopsis officinalis (Vill.: Fr.) Bond et Singer Brown trunk rot Quinine fungus	Larch, Douglas-fir, and ponderosa pine.	Slightly darkened areas	Cubically cracked dark red-brown wood. Thick white mats of fungal tissue present in cracks.	Rare; large, hoof-shaped to pendant, chalky.	1 conk indicates entire tree is cull (but conks are rare). Decay columnar if detected in log.
Laetiporus sulphureus (Bull.: Fr.) Murr. Brown cubical rot Sulfur fungus	True firs, Douglas-fir, white and ponderosa pines, larch, spruce, and hemlock.	Slightly darkened areas	Cubically cracked dark red-brown wood. Thick white mats of fungal tissue present in cracks.	Large clusters of overlapping soft shelves, somewhat fleshy. Top: orange. Underside: yellow. Becomes chalky with age.	Total cull if conk on log; usually butt log on trees.
Fomitopsis pinicola (Schwartz: Fr.) Karst Brown crumbly rot	All conifers (dead only).	Yellow-brown areas develop.	Wood becomes red-brown or yellow-brown and cubically cracked; some white fungal tissue present.	Large, perennial, flat to hoof shaped. Top: smooth gray with red band at edge. Underside: white pores.	Entire log cull if conks present. Entire log cull if decay at one end.
Phaeolus schweintizii (Fr.) Pat. Red-brown butt rot (Brown cubical butt rot)	Butts and roots of western conifers; most common in Douglas-fir, true firs, spruce, and hemlock.	Faint yellow to red-brown spires of discoloration in heartwood. Very inconspicuous.	Heartwood becomes red-brown, with some tendency toward large cubical cracking. This white mycelium may occur in shrinkage cracks. Decayed wood very brittle and crumbles easily to fine powder.	Irregular shelving; annual conk with thick short stalk grows in soil. Top: Velvety, dark red-brown. Underside: Yellow-green turning brown when old or bruised.	Conk in or near base of tree indicates 3' of tapered decay in butt log. May extend to 32' in ponderosa pine.
Hericium abietis (Weir ex Hubert) K. Harrison Yellow pitted rot	True firs, spruce, and hemlock. Continues in logs or fallen trees.	Elongate, spindle-shaped yellow-white spots form where pockets will develop.	Long-spindle-shaped pockets, separated by firm, natural colored wood. Pockets usually empty, but may contain a few white fibers.	White, soft, coral-like conks produced annually; rare on live trees.	Conk indicates complete cull; decay detected on log butt may extend 14' with irregular taper.
Cryptoporus volvatus (Pk.) Shear. Gray-brown sap rot	True firs, Douglas-fir, pines, larch, and hemlock (dead only).	Indistinct gray areas appear in sapwood.	Sapwood only; small, pale brown cubical, crumbly areas beneath conks.	Small, soft, round, yellow-white conks produced profusely for 2-3 years following tree death caused by bark beetles.	None; most of decay is outside the scaling cylinder.

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Table 1. Common decays in the Northern and Intermountain Regions.

(Continued from page 3)

SCIENTIFIC - COMMON NAME	HOSTS	INCIPIENT DECAY	ADVANCED DECAY	SPOROPHORE	CULL INDICATORS
Haematostereum sanguinolentum (Alb. & Schw. ex Fr.) Pouz. Red heart rot	Heart rot of living conifers. Also common in slash.	Wood water-soaked, reddish-brown.	Wood light, yellow-brown, dry, stringy, thin white fungal mats in shrinkage cracks.	Crust-like with shelving margins, pores underneath. Grayish, red fluid when bruised. Mainly fruits on dead trees.	Cull estimates not established, but is usually minor; localized.
Fomitopsis rosea (Alb. & Schw.:Fr.) Karst. Brown top rot Rose-colored fungus	Upper stems of true firs, larch, spruce, pines, Douglas-fir and hemlock.	Faint brown to yellow-brown color, grades into the color of surrounding wood.	Wood light yellowish to reddish brown and usually breaks into irregular cubes. A pinkish tinge barely discernible in decayed wood. Shrinkage cracks often have thin, whitish to rose-colored mycelial mats.	Small, bracket-like, abundant. Upper surface gray or black, rough. Lower surface finely pored and rose-tipped. Rare on living trees	Probably less than a total of 6' indicated by single conk or bunched conks.
Heterobasidion annosum (Fr.) Bref. White spongy rot (Annosus root and butt rot)	Western conifers; most common as a butt rot of true firs and hemlock. Also causes a root disease, particularly in pines.	Small, elongate, shallow pockets, often with black specks. Pockets slightly whiter than surrounding bleached wood.	Pockets merge, producing a very spongy white mass flecked with black. Zone lines occasionally appear in decayed wood.	Irregular in outline, usually less than 3" across, may shelve or be mostly crust like. Upper surface dark and concentrically furrowed. Lower surface white with small round pores Rarely produced except inside rotted stumps and on tree parts below ground level.	Conks on older trees, especially hemlock, indicate 8 to 10' of cull. Generally confined to butt log and deduction made by length cut.

Benefits for wildlife habitat

Numerous species of wildlife use decayed trees, live and dead, for habitation and foraging. The most common uses are nesting and roosting by various bird species, especially woodpeckers. Woodpeckers generally nest and roost in dead or partially dead trees and take advantage of the presence of fungal decay. Generally, some tree species are preferred for cavity construction. In the Pacific Northwest, preferred species include ponderosa pine, grand fir, lodgepole pine, western larch, and western red cedar (Parks, Bull, Torgersen 1997). Heartrot fungi are the typical decay group associated with woodpecker cavity excavation.

Benefits for wildlife habitat

Both white rots and brown rots are associated with cavities, but white rots appear to provide most opportunities (Jackson and Jackson 2004).

Figure 2. Cavity excavated in a tree with white pocket rot. USDA, Forest Service, Northern Region Forest Health Protection photo files.

A concept known as "pathological rotation" has been developed that indicates the maximum age at which a stand should be harvested if economic loss is to be avoided. Geographic location and tree species are determinants of pathological rotation.

This age may not agree with other rotation ages, such as culmination of mean annual increment.

Management to reduce stem and butt decay impact

Younger trees are practically free from decay, but the likelihood of occurrence of decay and the amount of decay increases with age. Sapwood decay can start at any age, but heart rots cannot start until heartwood formation begins. From that time on, trees are liable to decay, but it is usually many years later before decay of consequence is evident. Under managed conditions we expect the age at which decay causes consequential loss will be well beyond the actual rotation set by other considerations. Some exceptions will occur; advanced decay may be found occasionally in 20-year-old trees.

Management actions during the pre-planning stage

Some of the decay fungi are known to infect trees through branchlets at an early age and become dormant. These spores become incorporated into a tree as it grows. At later times when trunk wounds occur, these infections can become active and result in decay columns. Open wounds may be avenues for entrance of decay; the wound must be completely grown over before the tree is no longer exposed to infection. Wounds are caused by many agents; some of which can be controlled. Logging commonly wounds leave trees so that serious decay may result, particularly in thin-barked species such as hemlock and true firs.

Reducing injuries to residuals during thinning or partial cuts will help reduce the impact of decay fungi. In thin-barked species, and in some cases even thicker-barked species, this may mean special care in designing operations. The following pre-operation planning actions have been found to decrease damage.

Management

General management recommendations include:

- Restrict the logging season during the spring and early summer
- Match the size and type of equipment to the site, tree size, and soil type
- Match the type of equipment to the size of the material being removed
- Lay out skid trails in advance using straight line skid trails
- Mark the residual or leave trees
- Leave buffer trees or cull logs along the edges of skid trails and remove after the last turn
- Match log lengths with the final spacing of the residual stand
- During the operation, the following can help to minimize damage:
    - Gain the cooperation of the operator
    - Log skid trails first
    - Require directional felling
    - Limb and top prior to skidding

Management: Other operations

During partial cutting, remove all trees with decay indicators, large fire scars, and logging wounds. Consider the "pathological" rotation along with other factors when developing stand prescriptions.

Fire wounds can also be an entry point for decay fungi. During prescribed burning operations, prescriptions can be developed to limit the amount of heat that desired trees are exposed to so that cambium damage is minimized. In some cases with high value trees this may mean the actual mechanical removal of the litter and duff layer from around the base of trees before firing to limit smoldering and heating of the tree's base.

Other Reading

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Forest Health Protection and State Forestry Organizations

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