



United States
Department of
Agriculture

Forest Service

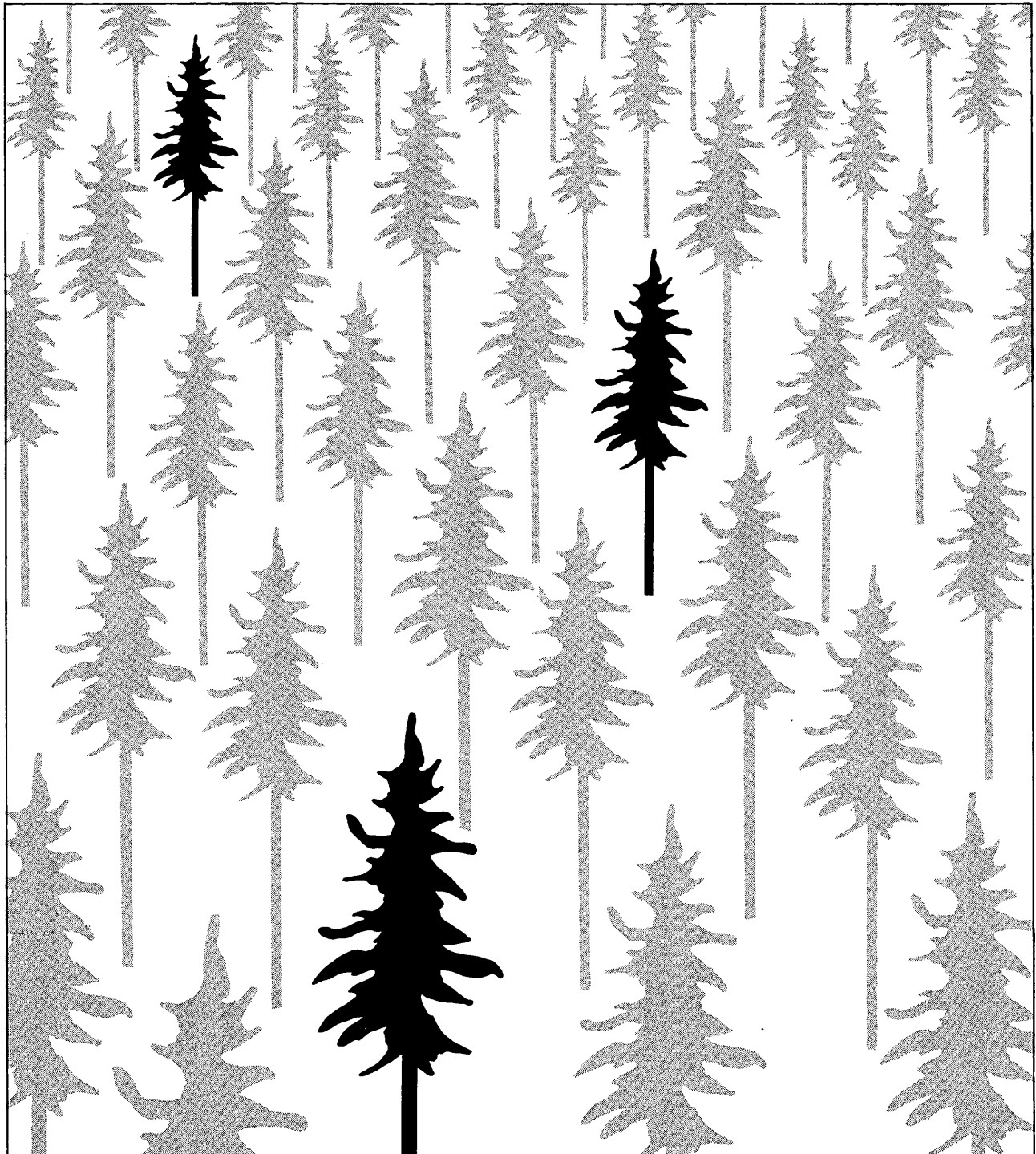
Pacific Northwest
Forest and Range
Experiment Station

General Technical
Report
PNW-144

September 1982

Indicators of Cull in Western Oregon Conifers

Paul E. Aho



This file was created by scanning the printed publication. Mis-scans identified by the software have been corrected; however, some errors may remain.

Author

PAUL E. AHO is a research plant pathologist, Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, Oregon 97331.

Abstract

Aho, Paul E. Indicators of cull in western Oregon conifers. Gen. Tech. Rep. PNW-144. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 17 p.

Descriptions and color photographs of important fungal sporophores (conks), other indicators of cull (wounds), and associated decays in western Oregon conifers are provided to aid timber markers, cruisers, and scalers in identifying them. Cull factors are given for the indicators by tree species.

Keywords: Cull logs, decay (wood), timber cruising, log scaling, coniferae, western Oregon.

Contents

1	Introduction
1	Defect Indicators
2	Decay Fungi
2	Red Ring Rot
4	Red Ring Rot (var. <i>cancriformans</i>)
5	Rust-Red Stringy Rot
6	Brown Trunk Rot
7	Red-Brown Butt Rot
8	Yellow Laminated Rot
9	White Spongy Rot
10	Mottled Rot
10	Yellow Pitted Rot
11	Brown Crumbly Rot
12	Brown Cubical Rot
12	Brown Top Rot
13	Pencil Rot
14	Injuries Indicating Associated Defect
14	Basal Injuries
14	Trunk Injuries
14	Frost Cracks
15	Top Injuries
15	Forks
15	Crooks
16	Swollen Butts
16	Dwarf Mistletoe Cankers
16	Additional Sources of Information
17	Appendix

Introduction

Timber cruisers and scalers must be able to estimate net volumes of standing trees and bucked logs accurately. Accurate inventories are essential to sustained-yield forestry. Forest land is classified, timber is sold, roads are built, and mills are developed from estimates of net volume obtainable from a given acreage of forest land. Serious financial losses can occur when less volume is harvested than cruisers report.

Cruisers and scalers need to recognize indicators of decay and other defects on logs and trees to predict net volumes accurately. Sporophores or conks of decay fungi are the most important indicators of decay in standing trees or logs. Amount of decay associated with conks depends on the species of fungus producing the conk. Fortunately, only a few fungi are responsible for most decay losses in western Oregon conifers.

Decay in trees is caused primarily by two classes of fungi, white rot and brown rot. White-rot fungi produce enzymes that can use all wood components; brown-rot fungi principally decompose cellulose. Wood with incipient (early) white-rot decay can usually be used for pulpwood and lower grade wood products. Wood in any stage of brown-rot decay cannot be used for pulp or lumber.

Indications that conks have been present or are developing are also useful in predicting presence and amount of decay. Pieces of old conks may still be attached or lying at the base of a tree. A hole in the bark may be where a branch has rotted out or where a conk was attached. Punk and swollen knots are produced commonly by some fungi, and these indicators are especially helpful to scalers. Most sporophores growing from the ground have no relation to decay in living trees, but an important exception is red-brown butt rot.¹ Conks of this fungus, reliable indicators of butt rot, are seldom found on living trees, but are commonly found on the ground at the base of trees with butt rot.

¹ Scientific names of all taxa mentioned in this paper are given in appendix table 3.

Defect Indicators

Type and age of all kinds of wounds can be used to determine presence and amount of decay in trees. Basal and trunk wounds, frost cracks, and top damage — such as dead or broken tops, forks, and crooks — are often excellent indicators of defect. Some abnormalities commonly seen on trees are seldom, if ever, associated with decay. Burls, closed dwarf mistletoe and rust cankers on the bole, and bark abnormalities not associated with wound callusing are examples. Infrequent or minor indicators of decay include recent (young) or small (less than 1 foot long) basal or trunk wounds, dead vertical branches, and open dwarf mistletoe and rust bole cankers.

The purpose of this paper is to help timber cruisers and scalers identify indicators of cull² and important decays found in the conifer species in western Oregon. Cull factors, if available, will also be given for important indicators on various tree species. Results of numerous studies on decay in Pacific Northwest conifers indicate that decay losses within and among tree species vary considerably from one locality to another and, to an even greater extent, from one region to another. Cull factors for a given tree species should be applied only to that species and only in the locality or area where the cull study was conducted. Because decay is so variable, familiarity with local conditions must be gained by observing cruised timber after it is felled and bucked, by observing decayed logs as they are opened by headsaws, and by comparing cruise estimates with gross and net log scales. The cull rules presented are averages for a tree species and usually are applicable in a limited area. They should be modified only when local knowledge or experience indicate that other cull deductions would be more appropriate.

² Cull includes decay, shake, and frost cracks. Defect, as used in this paper, is synonymous with cull.

Two general types of defect indicators are:

- Signs of decay fungi, such as fruiting bodies (conks, sporophores) and punky or swollen knots; and
- Injuries or wounds that are potential infection courts for decay fungi, including basal and trunk wounds, frost cracks or seams, rust and dwarf mistletoe bole cankers, and top damage, such as dead and broken tops, forks, and crooks.

Signs of decay fungi, especially conks, usually indicate that decay is present. Whether or not swollen knots, especially those on Douglas-firs and western hemlocks, are of fungal origin is sometimes difficult to determine, however. Decay is not always associated with injuries. Large, old wounds are most likely to be infected with decay fungi, and associated decay columns are also larger. Some types of indicators seldom have associated decay.

Decay Fungi



Figure 1. — Conk of red ring rot on the trunk of a Douglas-fir.



Figure 2. — Swollen knots caused by red ring rot on the trunk of a Douglas-fir.

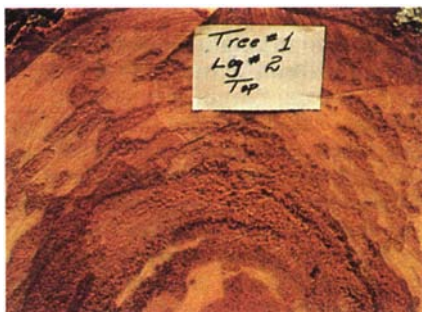


Figure 3. — Decay in a Douglas-fir caused by red ring rot.



Figure 4. — Close-up of red ring rot decay showing white pockets (white speck).

The first two fungi mentioned are the most commercially important causes of cull; the order in which the others are mentioned has no significance.

Red Ring Rot

Common names

For the decay: Red ring rot, conk rot, white pocket rot, pecky rot, white speckled rot.

For the fungus: Ring-scale fungus.

Hosts: Douglas-fir, larch, pines, hemlock, spruces, cedar, true firs, and Port-Orford-cedar.

Entry: Thought to be dead branches or stubs.

Location: Trunk

Conks: Perennial, produced at branch stubs and knots, rarely at wounds. Conks bracketlike to hoof shaped, with a brownish-black upper surface having concentric furrowed rings and a brown undersurface.

Rot: A cellulose and lignin-destroying white pocket rot attacking heartwood. Occasionally enters living sapwood. Can be confused with red ray rot, and red root and butt rot.

Early stage: Usually reddish but varies by host species; usually red-purple in Douglas-fir, light purplish-gray in spruce, pink to reddish in pines, colorless in cedar.

Late stage: Few to many spindle-shaped, white pockets with firm wood between. Pockets may run together; sometimes black zone lines are produced. Late stage may be distributed uniformly, may be in rings, or in crescent-shaped segments of rings.

Key identifying features:

- Swollen knots on logs;
- Punk knots on logs;
- White pockets in rot;
- Conks (when present);
- Rot column in rings or crescent-shaped segments of rings; and
- Conks on ground at base of tree.

Cull rules:

Tables 1 and 2 give cruising cull rules for Douglas-fir, western hemlock, and western white pine. Information helpful for modifying the cull deductions is:

- Conk rot is usually more severe:
From north to south in Oregon;
In older stands;
In pure stands than in mixed;
On steep slopes than on gentle;
On shallow than deep soils; and
On sites predominated by
secondary vegetation — vine
maple, vanillaleaf, oxalis, or rose,
rather than salal, twinflower, or
rhododendron.
- Conks are higher on trees in older stands.
- The larger the conk, the more related decay — unless the small conks are remnants of large conks that have fallen off.

Table 1 — Cruising cull rules for red ring rot in Douglas-fir, western hemlock, and western white pine

Tree and age	Visible indicator	Deduction
Douglas-fir		
Under 125 years	Conk	Degrade, but no cull
Over 125 years	Conk	See table 2
	Swollen knots	See table 2
Old-growth western hemlock, true firs (over 125 years)	Conks	Cull 16 feet for single conk; 16 feet above and below for group of conks
	Swollen knots	Cull 1/2 the distance figured for conks
Western white pine	Conks	Cull 2 feet above and 4 feet below each conk

Table 2 — Conk deduction in feet above the highest or below the lowest conk for Douglas-firs

Tree age	Conks		Swollen Knots	
	Below lowest	Above highest	Below lowest	Above highest
Years				
150	4	4	2	2
200	10	10	5	5
250	13	13	7	7
300	18	18	9	9
350	22	22	11	11



Figure 5. — Cross section from a white fir showing conks, cankers, and decay of red ring rot (var. *cancriformans*).



Figure 6. — Red ring rot (var. *cancriformans*) conks on cankered area of a white fir.

Red Ring Rot (var. *cancriformans*)

Common names:

For the decay: Red ring rot, conk rot, white pocket rot, pecky rot.

For the fungus: Butterfly conk, ring-scale fungus.

Hosts: Grand fir, white fir, California red fir, noble fir, Pacific silver fir, subalpine fir.

Entry: Thought to be dead branches and stubs.

Location: Butt and trunk.

Conks: Conks appear annual but are actually perennial, produced profusely over the surface of cankered areas, usually at the butt of tree rather than at branch stubs and whorls. Bracketlike, with rough upper surface and furrows, 1/2 to more than 3 inches wide. Dull grayish or brownish. In growing conks, lower margin velvety, light golden brown.

Rot: A cellulose- and lignin-destroying white pocket rot attacking sapwood and heartwood, often killing the cambium which causes cankered areas.

Early stage: Light yellow to light brown

Late stage: Few to many spindle-shaped pockets with firm wood between. Pockets may run together and may be filled with white, yellow, or brown material. Late stage may be uniformly distributed, may be in rings, or in crescent-shaped segments of rings.

Key identifying features:

- Sunken cankered areas;
- Conks (when present) scattered profusely over cankered areas;
- No swollen knots present; and
- Rot column in rings or crescent-shaped segments of rings.

Cull rules:

For white or red fir in southwestern Oregon, deduct 4 feet below the bottom of the lowest canker or conk and 6 feet above the top of the highest.



Figure 7. — Cross sections from a white fir showing Indian paint fungus conks and decay.

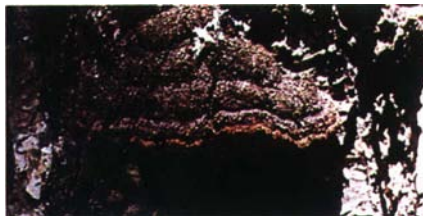


Figure 8. — Indian paint fungus conk on a grand fir.



Figure 9. — Felled white fir that split, showing stringy nature of decay from rust-red stringy rot.

Rust-Red Stringy Rot

Common names:

For the decay: Rust-red stringy rot, brown stringy rot.

For the fungus: Indian paint fungus.

Hosts: True firs and hemlocks, rare in other conifers.

Entry: Dead twigs less than 2 millimeters in diameter.

Location: Trunk.

Conks: Perennial conks hoof shaped, hard and woody; upper surface rough, black, furrowed, and cracked; lower surface covered with coarse, hard grayish spines (teeth). Interior brilliant rust red and brick red. Conks may be confused with those of red ring rot at a distance.

Rot: A brown, stringy rot causing heart-wood decomposition of lignin and, to a lesser extent, cellulose. Rot column frequently extensive.

Hidden stage: Wood can be affected seriously before discoloration or texture change is evident. Spring wood is weakened so that it separates during seasoning, producing the defect known as ring shake. Hidden stage may extend up to 5 feet beyond evidence.

Early stage: Softening of wood with a light yellow to brown or water-soaked stain, gradually deepening to pale reddish-brown. Fine rusty-red or even blackish lines may appear in early stage. Some crescent-shaped rings may form.

Late stage: Distinct brownish, reddish-brown, or rusty-red, very soft, and finally reduced to a brown, fibrous,

stringy mass. Brown to reddish zone lines often found. Sometimes white patches evident. Logs may be hollow where presence of rot is long standing.

Key identifying features:

- Conks (when present);
- Stringy, fibrous rot; and
- Rusty punk knots on logs (not swollen).

Cull rules: These cruising cull rules can be applied to rust-red stringy rot on white and red fir in southwestern Oregon.

<u>To estimate defect when:</u>	<u>Deduct:</u>
Conk is single, small, young	8 feet above and below conk
Lowest conk is 0 to 32 feet from ground	12 feet below conk: 21 feet above highest conk
Lowest conk is more than 32 feet from ground	20 feet below lowest conk: 21 feet above highest conk
Conks are in bottom third of tree	Middle and bottom third
Conks are in top third of tree	Top and middle third
Two or more conks are separated by 25 feet or more	Entire tree



Figure 10. — Brown trunk rot conk on Douglas-fir.

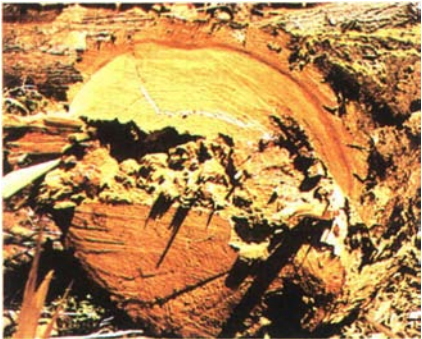


Figure 11. — Conk and decay from brown trunk rot on Douglas-fir.

Brown Trunk Rot

Common names:

For the decay: Brown trunk rot, red-brown heartrot.

For the fungus: Quinine fungus, chalky fungus.

Hosts: Douglas-fir, ponderosa and sugar pines, larch, and sometimes other western conifers.

Entry: Branch stubs, wounds, broken tops.

Location: Trunk

Conks: Rare, but unmistakable; Hard, perennial, and hoof shaped, becoming long and cylindrical after several years of development; at branch stubs or on wounds. Conks chalky white to grayish; surface ridged and extensively cracked. Conks soft and white inside, with a bitter flavor; hence the name "quinine fungus."

Rot: A brown, cubical, heartwood rot of top and trunk. Closely resembles brown cubical rot, accurate diagnosis often difficult. Quinine fungus rare in the butt; mostly brown cubical rot there. Thick, bitter-tasting mycelium in quinine fungus; mycelium of brown cubical rot thinner and not bitter.

Early stage: Frequently difficult to detect, color varies by host species. In Douglas-fir, coloration ordinarily not evident, but may be a brilliant purplish; color in ponderosa pine commonly red-brown or brown.

Late stage: Wood breaks down into a crumbly mass of yellow-brown to reddish-brown cubical chunks.

Mycelium: In the late stage, thick, whitish mycelial felts common in shrinking cracks between cubes. Felts may become onequarter of an inch thick and cover several square feet in a continuous sheet. Felts have characteristic bitter taste and resinous pockets or resinous crusty areas.

Red-Brown Butt Rot

Common names:

For the decay: Red-brown butt rot, red-brown rot.

For the fungus: Velvet-top fungus.

Hosts: Douglas-fir, pines, spruce, larch, hemlock, western redcedar, true firs.

Entry: Roots (basal scars).

Location: Butt and roots.

Conks: Annual, moist and cheesy when fresh; upper surface reddish brown, velvety with concentric rings and a light yellow margin. Die after a few weeks and become corky, leathery, and dark. Occur as thin brackets at tree base or as irregular saucers on nearby ground.

Rot: A cellulose-destroying, brown, cubical heartwood rot, commonly extending 2 to 10 feet above ground; rot column generally conical.

Early stage: Usually difficult to detect. Occurs as yellowish discoloration extending longitudinally an average of 2 feet beyond visibly decayed wood. Wood becomes soft and cheesy just before typical late stage is reached.

Late stage: Wood becomes soft, brittle, and breaks into large irregular cubes easily crumbled between fingers; reddish brown. Often has odor of turpentine.

Mycelium: Very thin mycelial layers, resembling crusts of resinous material, in shrinkage cracks between cubes.

Key identifying features:

- In butt log (swollen from ground up to 12 feet);
- Conks (when present);
- Cubes in late stage of rot; and
- Very thin mycelial felts between cubes.

Cull rules:

If the conk is found on a scar at the base of Douglas-fir and western hemlock or at the ground, deduct 8 feet of the butt log for young growth, and 16 feet of the butt log for old growth (8 feet on the Umpqua National Forest). If the conk is found on a scar 8 feet or more above the ground, deduct 32 feet.



Figure 12. — Old (left) and young (right) conks of red-brown butt rot, on the ground near the base of a tree.



Figure 13. — Red-brown butt rot associated with an old basal wound, in Douglas-fir.



Figure 14. — The root wad of a windthrown grand fir badly infected with yellow laminated rot.



Figure 15. — Yellow laminated rot in a grand fir.



Figure 16. — Sporophore of yellow laminated rot at the base of a Douglas-fir.

Yellow Laminated Rot

Common names:

For the decay: Yellow laminated rot, yellow ring rot, paper rot, laminated root rot.

For the fungus: Brown cedar poria.

Hosts: Western redcedar, hemlocks, true firs, Douglas-fir, Engelmann spruce, western larch, pines.

Entry: Primarily roots contacting infected roots and stumps.

Location: Butt and roots

Conks: Seldom found on living trees. Develop under roots, in root crotches, and in basal scars, and on undersides of logs. Perennial, dark chocolate brown, in flat, crust-like layers about onequarter of an inch thick, generally inconspicuous.

Rot: A white butt rot attacking lignin and springwood more readily than summerwood.

Early stage: Appears as a yellowing of the normal reddish-brown heartwood; the wood remains firm at first, but gradually darkens and softens; radial cracks form on drying.

Late stage: Wood becomes yellow brown to brownish and separates along annual rings, forming thin, papery layers. The thin layers have small elliptical pits parallel to the grain. On ends of logs, rot column may be crescent shaped at first but becomes uniformly circular as the decay develops.

Mycelium: Brownish strands of mycelial threads (setal hyphae) appear between laminated layers and in the elliptical pits.

Key identifying features:

- Separation of annual rings (lamination);
- Brown mycelial threads (setal hyphae); and
- In butt log.

Cull rules:

No cull rules have been established for yellow laminated rot. In Douglas-fir, decay seldom extends more than 5 to 6 feet above the ground. Stand openings with windthrown trees along the edge may indicate presence of the fungus within adjacent living trees.

White Spongy Rot

Common names:

For the decay: White spongy rot, annosus root rot, fomes root rot, spongy sap rot, white pocket rot, white stringy rot.

Hosts: Western hemlock, white pine, ponderosa pine, and other western conifers.

Entry: Roots and scars.

Location: Butt and roots.

Conks: Perennial, woody to leathery; develop on the lower side of living roots and root crotches, not easily seen. Usually thin, irregularly shaped, mainly occur as flat brown crusts, but sometimes bracketlike. White pore surface frequently incorporates litter into conk.

Rot: A white root and butt rot that decomposes lignin and, to a lesser extent cellulose, in both heartwood and sapwood.

Early stage: Appears as a pinkish to reddish-brown stain; wood firm.

Late stage: White fiber-filled pockets develop in affected sapwood or heartwood and eventually coalesce; wood separates at rings and finally becomes a white, stringy, spongy mass of fibers interspersed with black flecks of mycelium. Eventually wood may be destroyed and a hollow develop.

Key identifying features:

- In butt log;
- Frequently extends into sapwood;
- Black flecks in mycelium;
- Separation at annual rings; and
- Conks.

Cull rules:

For hemlocks, spruce, and some true firs, cull 16 feet of butt log if a conk occurs near the root collar and 4 feet above and below an infected wound.



Figure 17. — Decay from white spongy rot associated with a bear wound in western hemlock.



Figure 18. — White spongy rot sporophores at the base of a white fir.



Figure 19. — Sporophores from mottled rot



Figure 20. — Decay caused by mottled rot in white fir.

Mottled Rot

Common names:

For the decay: Mottled rot, brown mottled rot, yellow heartrot.

For the fungus: Yellow cap fungus.

Hosts: True firs, hemlock, white pine, spruce.

Entry: Trunk and basal wounds, dead and broken tops, branch stubs.

Location: Butt, trunk, and tops.

Conks: Gilled mushroom, rather than a conk. Mushrooms annual, fleshy, yellow on upper surface, sticky when wet, stems yellow, gills yellowish to brown. Develop singly in close groups from a common base. Appear in fall sometimes on living trees but mostly on snags, windfalls, or stumps, lasting only a few weeks.

Rot: May be confused with brown stringy rot caused by the Indian paint fungus.

Early stage: Light yellowish color in small areas of heartwood.

Late stage: Discolored areas enlarge and darken to honey color, and brown streaks appear, producing the mottled appearance that gives the rot its common name. Wood breaks up in the last stages after separation at annual rings, finally becoming hollow.

Mycelium: Threads consist of many parallel strands. When wood is split or cut fine, holes are left in the wood where strands are pulled out.

Key identifying features:

- Mushrooms (when present); and
- Mottled.

Cull rules:

The main infection courts for this fungus are wounds, particularly basal wounds. Use cull rules for wounds if available, because fruiting occurs infrequently. For white and red fir in southwestern Oregon, deduct 1 foot below the bottom and 2 feet above the top of the wound.

Yellow Pitted Rot

Common names:

For the decay: Yellow pitted rot, long pitted rot, long pocket rot.

For the fungus: Fir hydnum, coral fungus.

Hosts: Grand and subalpine firs, Engelmann spruce, hemlock

Entry: Wounds, dead branches.

Location: Mostly butt log, but not necessarily confined to that section.

Conks: Coral-like, white to cream, soft, annual conks produced on old logs or dead, fallen trees; occasionally on living trees at wounds. Conks characterized by open branching habit and formation of many spines or teeth; fleshy, short lived.

Rot: A white pocket or pitted heartwood rot in living trees and common in stumps, snags, and fallen trees; continues to develop in stored logs.

Early stage: Rot remains firm, appears as a yellowish to brownish discoloration with scattered darker spots, giving affected wood a mottled appearance. Pattern at end of logs generally irregular.

Late stage: Forms elongated pits (pockets) about one-half of an inch long; pits may contain yellowish to white fibers or may be hollow and separated by firm, reddish-brown wood. Similar to red ring rot, but pits longer with blunt ends.

Key identifying features:

- Large pockets with blunt ends; and
- Scattered dark flecks in rot column.

Cull rules:

The main infection courts for this fungus are wounds, particularly basal wounds. Use cull rules for wounds if available, because fruiting bodies occur infrequently. For white and grand fir in southwestern Oregon, deduct 1 foot below the bottom and 2 feet above the top of the wound.

Brown Crumbly Rot

Common names:

For the decay: Brown crumbly rot.

For the fungus: Red belt fungus, scavenger fungus.

Hosts: Attacks all important conifers, principally larch, hemlock, true firs, and Douglas-fir.

Entry: In living trees, through wounds or dead tops.

Location: Variable; in living trees, around wounds.

Conks: Conks unmistakable; one of the most commonly seen species of wood-decay fungi. Perennial, hard, tough, and hoof to shelf shaped. Upper surface smooth, zoned in gray to black, with a reddish band just inside a white wavy margin.

Rot: Principally a cellulose-destroying brown rot. Very important as a slash rot. Decay in living trees uncommon in the Northwest. Very harmful in deterioration of salvable, killed timber, down trees, and stored logs. Attacks sapwood rapidly, then progresses into heartwood.

Early stage: May appear as a faint brown to yellow-brown stain.

Late stage: Light reddish brown, forming a crumbly mass broken into rough, rather small cubes. Small patches of lighter color may give a mottled appearance on end of log.

Mycelium: Mycelial felts form in shrinkage cracks. Felts are thicker than most similar rots, but not as thick as quinine fungus. Unlike the velvet-top fungus, they are nonresinous.

Key identifying features:

- Brown cubes in late stage;
- Usually in old logs or logs from dead trees;
- Sapwood as well as heartwood affected; and
- Conks (when present).

Cull rules:

No cull rules have been established. Brown crumbly rot usually occurs only on dead wood. If on a living tree, it usually occurs on the face of a wound.



Figure 21. — Sporophore from yellow pitted rot on grand fir



Figure 22. — Sporophores from brown crumbly rot on a western hemlock.



Figure 23. — Sporophore from brown cubical rot.



Figure 24. — Sporophore from brown top rot on Douglas-fir.



Figure 25. — Brown top rot in Douglas-fir.

Brown Cubical Rot

Common names:

For the decay: Brown cubical rot, red-brown heartrot.

For the fungus: Sulphur fungus, chicken-of-the-woods.

Hosts: Douglas-fir, white and ponderosa pines, true firs, larch, hemlock, and spruce.

Entry: Wounds, branch stubs.

Location: Sometimes trunks, generally butts.

Conks: Conks one of the most conspicuous of all wood-decay fungi; many often appear in fall on wounds at or near the base of living trees, on stumps, and on fallen logs. Annual, brilliant orange to red orange above and sulphur yellow below. Generally thin and broad, with several parts one above another; edges wavy.

Rot: A cellulose-decomposing, heartwood and occasionally sapwood, brown, cubical rot with mycelial felts. Can be confused with brown trunk rot, red-brown butt rot, or brown crumbly rot.

Hidden stage: Hidden stage usually present; detectable only by microscopic or cultural study.

Early stage: Appears as a light-brown stain.

Late stage: A dark reddish-brown decay breaking into medium-sized irregular cubes. May look rippled in longitudinal section. Cracks of cubes are often completely filled with white mycelial felts plainly evident in cross section, appearing as a network. These felts do not have resin pockets like brown trunk rot (quinine fungus) nor resinous crusts like red-brown butt rot (velvet-top fungus).

Key identifying features:

- A brown cubical rot;
- Generally in butt rather than trunk;
- Conks (rare on logs); and
- Mycelial felts, if typical.

Cull rules:

No cull rules have been established

Brown Top Rot

Common names:

For the decay: Brown top rot.

For the fungus: Rose-colored conk.

Hosts: Douglas-fir, grand fir, larch, lodgepole and white pines, spruce, and other western conifers.

Entry: Broken tops (branch stubs).

Location: Upper trunk.

Conks: Delicate, rose-colored under-surface and inner tissue; perennial, woody, bracketlike to hoof shaped; usually appear in a shelving arrangement. Upper surface brown to black, usually cracked and roughened.

Rot: A brown, cubical heartwood rot in living trees, often limited to the top log or unmerchantable top. Frequently found in dead trees, both standing and down; develops rapidly. May continue to develop in wood in service; important in piled logs and pulpwood.

Hidden stage: Wood often moderately affected before discoloration or texture change becomes evident.

Early stage: A faint brownish or yellow-brown stain, outer limits sometimes marked by a greenish-brown zone line.

Late stage: Yellowish to reddish brown, soft, irregularly broken into cubes.

Mycelium: Thin mycelial felts, which vary from white to faint rose-colored, often develop in the cracks between cubes.

Key identifying features:

- Upper trunk and tops;
- Conks (when present);
- Mycelium; and
- Dead or broken tops.

Cull rules:

Conks are difficult to see at the tops of trees. The best indicator is usually the dead or broken top which may be on the ground. For Douglas-fir and hemlocks with conks or a broken top, deduct 16 feet below the indicator.

Pencil Rot

Common names:

For the decay: Pencil rot, pecky rot, pocket dry rot, pecky cedar, pine rot, incense-cedar dry rot.

For the fungus: Incense-cedar fungus.

Hosts: Incense-cedar, some true firs.

Entry: Fire and other wounds and branch stubs.

Location: Butt and bole.

Conks: Annual sporophores at knots, usually in the summer or autumn; rare. Conks bracket shaped with rounded tops or half-bell shaped. Young conks soft and mushy with a smooth, tan top and a bright sulphur-yellow undersurface with numerous small tubes that sometimes exude clear drops of a yellow, sweet liquid. With age, conks become tough and cheesy, turning brown and finally hard and dry. Last stage rare because insects, birds, and squirrels destroy the conk. A shot-hole cup forms at and below the knot where a conk destroyed by insects or birds had been attached.

Rot: A typical brown cubical rot that attacks cellulose and forms pockets separated by apparently sound wood.



Figure 26. — A shot-hole cup in incense-cedar caused by pencil rot. Note that part of the old conk is still attached.

Early stage: At first, firm and faintly yellowish brown in the pockets. The color deepens slightly with time and the wood becomes soft. This stage extends only a short distance vertically beyond the late stage.

Late stage: Pockets filled with a dark-brown, carbonaceous crumbly mass. A sharp separation occurs between decayed and sound wood.

Mycelium: Small, cobweblike or feltlike masses of white mycelium may occur in pockets.

Key identifying features:

- Conks (when present);
- Shot-hole cups at or below knots; and
- Brown cubical pocket rot.

Cull rules:

For incense-cedar, conk or shot-hole cup indicates a cull tree. Decay is almost always present in trees over 40 inches diameter at breast height and in trees with basal wounds or old, dead limbs.



Figure 27. — Sporophore from pencil rot on incense-cedar.



Figure 28. — Cross section of incense-cedar log showing pencil rot decay.

Injuries Indicating Associated Defect



Figure 29. — Old basal injury probably caused by fire.

Basal Injuries

Basal injuries — open or closed wounds in contact with the ground — are important defect indicators for all tree species. They may be caused by animals, fires, falling trees, or mechanical equipment. Sometimes inconspicuous, they may be easily overlooked. Basal wounds less than 10 years old should be ignored because little or no defect is usually associated with them.

Cull rules:

For white and red fir in southwestern Oregon; deduct 9 feet above the top of the wound.



Figure 30. — Trunk injury indicating internal defect.

Trunk Injuries

Trunk injuries are important indicators for all tree species. They include open or closed wounds more than 1 foot long, more than 10 years old, and located below the merchantable-top diameter, but not in contact with the ground. They are caused by falling trees, logging equipment, lightning, and animals. Small, young wounds are unreliable indicators of decay.

Cull rules:

For white and red fir in southwestern Oregon, deduct 1 foot below the bottom and 2 feet above the top wound.

Frost Cracks

Frost cracks may occur in any species, but they are important defect indicators mainly in true firs and hemlocks. Frost cracks or seams are associated with wounds and wetwood. The cause of wetwood is unknown, but it appears to develop in true firs after wounding. The inrolled callus growth as a wound heals is a weak point in a tree. Freezing of



Figure 31. — A frost crack at the base of a white fir.



Figure 32. — Cross section at the base of a white fir showing frost cracks, shake, and wetwood.

the tree causes a crack to develop from the face of the injury through the bark. In time, the crack may increase longitudinally, and other seams may develop at right angles to the original crack, resulting in a star-shaped pattern. Frost cracks are seldom infection courts for decay fungi. Occasionally, old wounds from which the frost crack originated may have associated decay columns. Because old wounds may no longer be visible, frost cracks are the indicators of defect.

Cull rules:

No cull rules are available for frost cracks.



Figure 33. — Broken top in the merchantable portion of a white fir tree.



Figure 34. — White fir with a dead top caused by beetle attack.

Top Injuries

Top injuries include tops broken by wind, ice, or snow and dead tops caused by insects, rust fungi, dwarf mistletoe, and animals. Recent top damage and damage occurring above the merchantable-diameter limit are not defect indicators.



Figure 35. — A forked white fir tree.

Forks

Forked trees usually result when two or more branches replace a dead or broken leader.



Figure 36. — White fir with a crook caused by death of the leader. Presence of the old, dead top indicates decay.



Figure 37. — Crook resulting from bending of young tree by snow or ice. No break occurred, so no decay is present.

Crooks

Crooks are sudden bends in the merchantable bole of a tree. Crooks may result when young trees bend under ice or snow. This type of crook is free of decay. In older trees, crooks may result from breaks or leader death when a lateral branch assumes dominance and becomes the new tree top. Decay usually is present if the older leader or broken top still remains at the crook.

Additional Sources of Information



Figure 38. — White fir tree with a swollen butt resulting from healing of an old injury.

Swollen Butts

Swollen butts are often caused by healing of an old wound or by the reaction of a tree to a root-rot fungus.



Figure 39. — A dwarf mistletoe bole canker with tight bark; no decay should occur.



Figure 40. — Open dwarf mistletoe canker on a white fir. Decay may be present, but seldom extends beyond the limits of the swelling.

Dwarf Mistletoe Cankers

Dwarf mistletoe cankers are large pronounced swellings or cankers produced on branches or boles of host trees by dwarf mistletoes. If the bark is tight, these cankers do not admit decay fungi. When the bark on one of these cankers sloughs off and exposes wood, infection by decay fungi can occur. In white fir, decay generally does not extend beyond the limits of the swelling.

Cruisers and scalers in western Oregon may want to search out additional technical information. The following publications will help in making more precise estimates of net volumes in standing trees and logs:

Aho, Paul; Hadfield, Jim. How to estimate defect in white fir in southwest Oregon. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1975. 12 p.

Aho, Paul E.; Roth, Lewis F. Defect estimation for white fir in the Rogue River National Forest. Res. Pap. PNW-240. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978. 18 p.

Boyce, J.S.; Wagg, J.W.B. Conk root of old-growth Douglas-fir in western Oregon. Bull. 4. Corvallis, OR: Oregon State University, Forest Products Laboratory; 1953. 96 p.

Childs, T.W. Estimating decay in west-side Douglas-fir. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1959. 8 p.

Hunt, J.; Krueger, K.W. Decay associated with thinning wounds in young-growth western hemlock and Douglas-fir. J. For. 60 (5): 336-340; 1962.

Shea, K.R. Decay in logging scars in western hemlock and Sitka spruce. For. Res. Note 25. Centralia, WA: Weyerhaeuser Timber Company; 1960. 13 p.

Wright, E.; Isaac, Leo A. Decay following logging injury to western hemlock, Sitka spruce, and true firs. Tech. Bull. 1148. Washington, DC: U.S. Department of Agriculture; 1956. 34 p.

Appendix

Table 3 — Scientific names of taxa mentioned in the text

Common name	Scientific name
Fungi¹	
Red ring rot	<i>Phellinus pini</i> (Thore ex Fr.) A. Ames
Red ring rot (var. <i>cancriformans</i>)	<i>Phellinus pini</i> (Thore ex Fr.) A. Ames var. <i>cancriformans</i> Larsen, Lombard, et Aho
Red ray rot	<i>Dichomitus squalens</i> (Karst.) Reid
Red root and butt rot	<i>Inonotus circinatus</i> (Fr.) S. C. Teng
Rust-red stringy rot	<i>Echinodontium tinctorium</i> (Ell. et Ev.) Ell. et Ev.
Brown trunk rot	<i>Fomitopsis officinalis</i> (Vill. ex Fr.) Bond. et Sing.
Red-brown butt rot	<i>Phaeolus schweinitzii</i> (Fr.) Pat.
Yellow laminated rot	<i>Phellinus weiri</i> (Murr.) Gilbn.
White spongy rot	<i>Heterobasidion annosum</i> (Fr.) Bref.
Mottled rot	<i>Pholiota limonella</i> (Pk.) Sacc.
Yellow pitted rot	<i>Hericium abietis</i> (Weir ex Hubert) K. Harrison
Brown crumbly rot	<i>Fomitopsis pinicola</i> (Swartz ex Fr.) Karst.
Brown cubical rot	<i>Laetiporus sulphureus</i> (Bull. ex Fr.) Bond. et Sing.
Brown top rot	<i>Fomitopsis cajanderi</i> (Karst.) Kotl. et Pouz.
Pencil rot	<i>Tyromyces amarus</i> (Hedgc.) Lowe
Trees	
Douglas-fir	<i>Pseudotsuga menziesii</i> (Mirb.) Franco
Fir	
California red	<i>Abies magnifica</i> A. Murr.
Grand	<i>A. grandis</i> (Dougl. ex D. Don) Lindl.
Noble	<i>A. procera</i> Rehd.
Pacific silver	<i>A. amabilis</i> Dougl. ex Forbes
Subalpine	<i>A. lasiocarpa</i> (Hook.) Nutt.
White	<i>A. concolor</i> (Gord. & Glend.) Lindl. ex Hildebr.
Hemlock	
Mountain	<i>Tsuga mertensiana</i> (Bong.) Carr.
Western	<i>T. heterophylla</i> (Raf.) Sarg.
Incense-cedar	<i>Libocedrus decurrens</i> Torr.
Larch, western	<i>Larix occidentalis</i> Nutt.
Pine	
Lodgepole	<i>Pinus contorta</i> Dougl. ex Loud.
Ponderosa	♂ <i>ponderosa</i> Dougl. ex Laws.
Sugar	♂ <i>lambertiana</i> Dougl.
Western white	♂ <i>monticola</i> Dougl. ex D. Don
Whitebark	♂ <i>albicaulis</i> Engelm.
Port-Orford-cedar	<i>Chamaecyparis lawsoniana</i> (A. Murr.) Parl.
Redcedar, western	<i>Thuja plicata</i> Donn ex D. Don
Spruce	
Engelmann	<i>Picea engelmannii</i> Parry ex Engelm.
Sitka	♂ <i>sitchensis</i> (Bong.) Carr.

¹ Fungi are in order of mention in text

Aho, Paul E. Indicators of cull in western Oregon conifers. Gen. Tech. Rep. PNW-144. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 17 p.

Descriptions and color photographs of important fungal sporophores (conks), other indicators of cull (wounds), and associated decays in western Oregon conifers are provided to aid timber markers, cruisers, and scalers in identifying them. Cull factors are given for the indicators by tree species.

Keywords: Cull logs, decay (wood), timber cruising, log scaling, coniferae, western Oregon.

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

The U.S. Department of Agriculture is an Equal Opportunity Employer. Applicants for all Department programs will be given equal consideration without regard to age, race, color, sex, religion, or national origin.

Pacific Northwest Forest and Range
Experiment Station
809 NE Sixth Avenue
Portland, Oregon 97232