Common Defects 4

If all logs were smooth, round, and sound, scaling would be simple. Because they are not, it is necessary for the scaler to find the amount of volume lost from various defects. In general, the defects in logs with which the scaler is concerned will fall into three major classifications: defects due to rot fungi, defects due to other natural causes, and defects due to handling. This chapter will provide the scaler with a working concept of many common defects encountered in logs, but is not intended to be a comprehensive study of tree diseases.

4.1 An Overview of Rot Fungi

The sapwood of a tree is a living tissue capable of isolating damaged portions of itself and capable of interaction with invading micro-organisms. Healthy sapwood is divided into numerous compartments separated by special cells. When sapwood is wounded, the tree starts processes, called compartmentalization, that isolates the wound from normal tissues. The special cells near the wound produce and secrete substances that make the wood toxic or inhibitory to micro-organisms (fungi) and more or less impervious to water. These substances include gums, phenolic compounds, turpentine, and resins. Vessels that would normally conduct sap become plugged with these substances above and below the wound and near the wound edges. The surrounded wood dies and oxidation of phenolic compounds causes the wood to darken (stain).

The region of sapwood response around the wound is called the reaction zone and extends farther up and down the stem than inward or to either side because of the way the wood elements are arranged. The nearby cambium is also stimulated to produce chemicals like those mentioned above, resulting in a thin layer of new xylem (wood tissues) more impervious than the older wood. The newly formed barrier zone separates the sapwood present before wounding from that produced subsequently; the barrier zone therefore forms within a growth ring, forcing the rot, as it invades the wood, to follow a circular shape or ring.

As soon as a wound occurs, different micro organisms in succession, begin to invade and to spread into surrounding wood. Bacteria and molds that grow rapidly by utilization of simple carbon compounds in the wound are the first colonists. They include or are followed by fungi that are able to grow into the reaction zone and detoxify inhibitory chemicals or use them as nutrients. These organisms expand up, down, and inward from the wound, causing dark discoloration of the wood by converting chemicals in the reaction zone to coloured products, but they do not cause decay. After staining fungi detoxify the wood, the decay fungi move in, months to years after wounding. Decay fungi are able to degrade complex polymers- lignin, cellulose, and hemicelluloses - and use them as carbon sources. This is the main event in wood decay, and emphasizes the difference between stain and rot.

Micro organisms in succession, continually confronted by the reaction of the chemicals produced by the tree, slowly advance and cause discoloration followed by decay within wood that was present before wounding. The barrier zone however, is not breached. Therefore sapwood formed after wounding usually remains healthy. Some organisms, however, are specialized for invading sapwoods. A tree may sustain wounds at various times, resulting in multiple, overlapping zones of discolouration and decay, making assessment even more difficult for the scaler.

Rot fungi are sub-classified into root, and butt rots, heart or trunk rots and sap rots and stains according to their characteristic spread. The following list illustrates the typical areas of infection of many fungi common to British Columbia.

4.1.1 Common Root and Butt Rots

- Brown cubical butt rot (*Phaeolus schweinitzii*) or velvet top fungus,
- brown cubical trunk and slash rot *(Laetiporus sulphureus)* or sulfur fungus,
- cedar pocket rot (Postia sericiomollis) formerly *Poria sericiomollis* or *Polyporus asiatica*,
- stringy butt rot or Feather rot (*Perenniporia subicida*),
- annosus root and butt rot *(Heterobasidion annosum)* formerly *Fomes annosus*,
- tomentosus root rot or Red root and butt rot *(Inonotus tomentosus)* formerly *Polyporus tomentosus*,
- armillaria root disease or shoestring root rot *(Armillaria ostoyae)*, and
- laminated root rot or yellow laminated rot *(Phellinus weirii).*

4.1.2 Common Heart Rots

- Red Fomes rot or Brown top rot *(Fomitopsis cajanderi)* or rose conk formerly *Fomes subroseus*,
- brown trunk rot *(Fomitopsis officinalis)* or elephant foot (quinine) fungus,
- red rot or red ray rot (*Polyporus anceps*),
- red ring rot or white pocket rot *(Phellinus pini)* formerly *Fomes pini*,

- brown stringy trunk rot *(Echinodontium tinctorium)* or Indian paint fungus,
- hardwood white trunk rot (*Phellinus igniarius*) formerly *Fomes igniarius*,
- aspen trunk rot *(Phellinus tremulae)* formerly thought to be *Fomes igniarius,*
- white stringy trunk rot or White spongy trunk rot *(Fomes fomentarius),*
- long yellow pitted rot *(Hericium abietis),*
- red heart rot *(Stereum sanguinolentum)* or bleeding fungus (conk) formerly *Haematostereum sanguinolentum*,
- white mottled rot (*Ganoderma applanatum*) or Artist's conk,
- conks, general,
- rotten knots (Conk knots), and
- pipe or pocket rots, general.

4.1.3 Sap Rots and Stains

- Black stain root disease or Blue stain (*Leptographium wageneri*, *Ceratocystis* and *Graphium*),
- brown crumbly rot (*Fomitopsis pinicola*) or red belt fungus,
- brown cubical sap rot (*Gleophyllum saepiarium*) formerly *Lenzites saepiaria* (or *Trametes americana*, and *Trametes serialis*),
- grey-brown sap rot (*Cryptoporus volvatus*) formerly *Polyporus volvatus*, and
- pitted sap rot (*Trichaptum abietinum*) formerly *Herschioporus abietinus* and *Polyporus abietinus.*

4.2 Root and Butt Rots

4.2.1 Brown Cubical Butt Rot

Root rot and stump rot are often caused by the velvet-top fungus long known as *Polyporus schweinitzii* (now *Phaeolus schweinitzii*). It is one of the most common root and butt rots in both natural and planted coniferous forests, and it also causes damage to conifers in landscapes.

4.2.1.1 Species Affected

All British Columbia conifers are affected except juniper, and it is especially common on spruce, pine, fir, western red cedar, larch and hemlock. It does not occur in hardwoods. It is considered to be the most serious butt rot pathogen of conifers in old-growth forests. This fungus is often considered to cause significant butt rot, mainly in mature trees, but this is a misconception based on delayed discovery. The fungus may infect roots of any age and may enter the stems of young trees through roots or basal wounds. Decay eventually involves most of the cross-section of the butt and usually extends less than 3 m up the trunk before the tree breaks or is wind thrown during a storm. Decay columns extending more than 10 m into the trunks of pines and further in Douglas-fir have been reported.

4.2.1.2 Rot Description

Wood in the incipient stages of decay is stained pale yellow or yellow-brown to reddish brown. It loses strength rapidly, gradually becoming dry and crumbly, and in the later stages turns darker brown and cracks into more or less cubical pieces, often having a pungent odour like turpentine or oil of anise. It is interesting to note that cubical rot consumes the cellulose (fibre) and leaves the lignin (glue), whereas other rots will do the opposite. In combination, they leave nothing but a hollow space in the trunk.

4.2.1.3 Indicators of Decay

The annual conks of *Phaeolus schweinitzii*, generally develop on the duff around the base of decayed trees, although occasionally they develop on the butt of the tree. On trees they are thin and bracket-like; growing on the ground, they are more or less circular and stalked. The upper surface is reddish-brown and velvety or plush-like with concentric zones. The under surface is olive green on fresh growing conks and dark reddish-brown on dead ones. Basal scars are so generally invaded by this fungus that they are quite reliable indicators of decay. When red-brown butt rot is present in a tree, it is almost always visible on the lower end of the butt log.

4.2.1.4 Extent of Decay

This type of rot is generally conical in shape; the height of the cone is the distance the rot extends into the log. This distance is found mainly by experience gained from local conditions.

4.2.2 Brown Cubical Trunk and Slash Rot

A trunk rot caused by *Laetiporus sulphureus* or the sulfur fungus, it is similar in appearance to brown cubical butt rot and is treated as a butt rot by the scaler.

4.2.2.1 Species Affected

The sulfur fungus is responsible for trunk rot in a wide range of coniferous and deciduous hosts including spruce, white pine, fir, larch and yellow pine, but is most common in western hemlock, Sitka spruce and garry oak.

4.2.2.2 Rot Description

Laetiporus sulphureus decays the heartwood of living conifers and usually causes a butt rot. The rot is commonly observed in stumps and fallen trees. In the early stages of this rot, a light brownish discoloration or stain is observed; and the advanced stage is very similar to that of brown trunk rot. The wood becomes a brown, crumbly mass of more or less cubical chunks, sometimes having a rippled appearance, and conspicuous mats of white fungous tissue may form in the shrinkage cracks within the decay. On the ends of logs, the appearance of the rot is almost exactly like that of brown cubical butt rot; the cubical structure of the brown decayed wood and the white mats are very noticeable. The rot column is generally circular in outline; and in trees with long-established rot, hollow butts are common.

4.2.2.3 Indicators of Decay

Conks of *Laetiporus sulphureus,* often spreading profusely over a large area on the base of living trees, stumps, and fallen trees, are annual, thin, and bracket-like. They are a bright orange on the upper surface and sulfur yellow on the under surface, which has small circular pores. Fading out as the conk ages or is dried, the bright tones eventually become straw-coloured or almost white; the conks deteriorate rapidly in the late fall. Living trees are infected through basal wounds and dead branch stubs.

4.2.2.4 Extent of Decay

This rot is generally confined to the butt log and is one of the more common butt rots. It is generally conical in shape.

4.2.3 Cedar Pocket Rot

Brown pocket rot is caused by *Postia sericiomollis (Polyporus asiatica).* Also called cedar pocket rot, it is both a butt and trunk rot. Another brown pocket rot caused by *Lentinus kauffmanii* is responsible for an important butt and trunk decay in Sitka spruce.

4.2.3.1 Species Affected

Common in living Western red cedar and ranks second only to *Phellinus pini* as the most common fungus responsible for decay in red cedar. It is also a slash rot in other conifers.

4.2.3.2 Rot Description

Although brown pocket rot in cedars is most commonly found in the butt, it may extend throughout the length of the tree. The incipient or earliest stages of decay appears as straw coloured to a pale yellow-brown discoloration. Later the wood becomes soft and loses its natural lustre. In the advanced stages, the wood cracks extensively and breaks down into a fragile, crumbly mass of brown cubes; and whitish or cream-coloured fungus tissue develops in the cracks. The decay first develops in isolated, well-defined pockets. In the butt of the tree, these pockets run together and often form solid cylinders of rot. On ends of logs the rot commonly appears in small scattered pockets, concentric ring-shaped areas, or as solid circular areas. Large hollows often develop in the butt of older trees.

4.2.3.3 Indicators of Decay

Conks of *Polyporus sericeomollis (Pona asiatica)* rarely, if ever, appear on living cedars, even when the decay is extensive and long-established. Consequently there is no specific indication of decay on the living tree. Conks develop on dead material and are abundant on slash of other conifers. They are white, thin, and crust-like with small regular pores and have a very bitter taste.

4.2.3.4 Extent of Decay

In the earlier stages of decay, the rot is in round or cubical isolated sections. In advanced stages of butt rot, the rot may be treated as being conical. If the rot extends the length of the log, it is treated as a cylinder of rot.

4.2.4 Stringy Butt Rot or Feather Rot

This rot is known as spongy root rot, white spongy rot and white stringy rot. It is caused by *Perenniporia subicida*.

4.2.4.1 Species Affected

This rot attacks a wide range of coniferous and deciduous hosts but is most damaging on balsams (true firs), spruce, and hemlock.

4.2.4.2 Rot Description

Stringy butt rot is one of the most common slash rots on conifer wood in British Columbia. It is found in dead standing trees, stumps, and stored logs. In addition, it occurs frequently as a butt and root rot of living trees, especially in western white pine. Faint pinkish to brownish discoloration of the wood mark the early stages. As decay progresses, elongated whitish streaks appear in the spring wood of the annual growth ring. These streaks enlarge and run together, and the wood separates easily at the annual rings. Black flecks often appear among the white fibres. As decay continues, the wood breaks down into a whitish stringy mass of soft, spongy, water soaked material. In the advanced stages of decay, cream-coloured mats of fungous tissue with golden brown flecks usually develop in the wood. On the ends of logs, this rot is roughly circular in outline; the white, stringy nature of the decayed wood and the fungous tissue serve to identify it.

4.2.4.3 Indicators of Decay

Conks of *Perenniporia subicida* are flat and crust-like with small circular pores. The perennial conks are cream to almost lemon yellow in colour. Conks develop in root crotches of living trees and on the under surface of dead material on the ground.

4.2.4.4 Extent of Decay

In old-growth timber, the rot characteristically hollows out the centre section and leaves a clear shell. This rot rarely extends beyond 5 m in length and is confined to the butt log. Therefore it is also treated as butt rot approximating the shape of a cone.

4.2.5 Annosus Root and Butt Rot

Formerly known as *Fomes annosus, Heterobasidion annosum,* this rot is also called spongy sap rot, white pocket rot, and brown root and butt rot.

4.2.5.1 Species Affected

Heterobasidion annosum is known throughout the temperate zone as the cause of butt rot of mature coniferous trees, and of butt and root rot that seriously affects the growth and survival of plantations and young forests. The fungus has a very wide host range including both coniferous and broad-leaved species. Hemlock appears to be the most highly susceptible of the native coniferous species.

4.2.5.2 Rot Description

Heterobasidion annosum causes a root and butt rot of living trees and is a common slash rot of conifers. In the early stages of decay the wood is firm and pinkish to reddish-brown in colour. White pockets of decay appear in the discoloured wood as decay progresses. These pockets are elongated parallel to the grain and frequently have black flecks in the centre, running parallel to the grain. The pockets enlarge and run together; the wood tends to separate at the annual rings, and a soft spongy mass of fibrous rotten wood with black flecks eventually results. In the early stages, the rot appears on the ends of butt logs as dark reddish-brown areas of discoloured heartwood or as circular areas of whitish, spongy, decayed heartwood surrounded by a dark zone of early decay. In the final stage, the wood is completely destroyed, leaving a hollow butt.

4.2.5.3 Indicators of Decay

Conks of *Heterobasidion annosum* are perennial and are generally inconspicuous, developing under logs and roots or in root crotches of living trees. The upper surface of the conk is grey to black with a hard, smooth crust. The under surface is cream coloured with small circular pores. Conks developing under logs or roots are commonly flat and cream coloured with a brownish-black margin. Resin flow may occur at the base of infected trees.

4.2.5.4 Extent of Decay

This rot is generally confined to the butt log and is approximately conical.

4.2.6 Tomentosus Root Rot

Tomentosus root rot is caused by *Inonotus tomentosus.*

4.2.6.1 Species Affected

Western white pine and yellow pine are the major hosts of tementosus root rot in British Columbia. Engelmann spruce, western larch, lodgepole pine, Douglas-fir, and western hemlock are also decayed by this fungus.

4.2.6.2 Rot Description

Tomentosus root rot is generally confined to the lower portion of the butt log, the fungus entering the tree through basal scars or perhaps through injured roots. In the early stages of decay the wood is discoloured, dark reddish-brown, and firm. In the later stages, narrow, lens-shaped pockets develop parallel to the grain. These pockets are filled with white decayed wood and are separated by reddish-brown firm wood. The rot is important only in living trees and is of little consequence in the decay of slash.

4.2.6.3 Indicators of Decay

Conks of *I. tomentosus* develop on the ground near the roots of a decayed tree or on the butt of the tree. Conks on the ground are stalked with a thin circular cap, and those on trees are usually thicker and more or less bracket-like. Both are yellowish-brown with a velvety or plush-like upper surface.

4.2.6.4 Extent of Decay

This rot is generally confined to the basal portion of the first log, rarely extends beyond 2 or 2.5 m and is approximately conical in shape.

4.2.7 Armillaria Root Disease

Also known as Armillaria root rot or White butt rot, it is caused by *Armillaria ostoyae.*

4.2.7.1 Species Affected

Most conifers and hardwoods in British Columbia are susceptible to shoestring or Armillaria root rot. It is common in western white pine, yellow pine, Douglas-fir, and particularly in western hemlock, western red cedar and the balsams (alpine fir, amabilis fir and grand fir).

4.2.7.2 Rot Description

Armillaria ostoyae causes the decay and death of sapwood in the roots and butts of living trees. Entering the tree through the roots and growing upward past the root collar, it often girdles the tree completely. In the early stages of decay, the wood appears water soaked and shows a pale brownish discolouration. Eventually it becomes whitish, soft, and spongy or stringy with conspicuous narrow black zone lines running through the decayed wood. A white butt rot in the heartwood of older trees is also reported to be caused by *Armillaria ostoyae.*

4.2.7.3 Indicators of Decay

The presence of armillaria root disease may be indicated by abundant resin flow on the bark of the butt portion of the tree. Removal of bark from the root collar of infected trees reveals the presence of white fans of fungous tissue in the cambium region between bark and wood. Long, narrow, whitish to black strands of fungous tissue may be present under the bark and in the duff around the base of infected trees. These strands, called "rhizomorphs," have given rise to the common name of shoestring root rot. In the fall, conks of *Armillaria ostoyae* may develop at the base of infected trees and stumps; or they may develop on the ground from infected roots. The conks that often grow in dense clusters are honey-coloured mushrooms with circular caps; the under surfaces of the caps have radial gills.

4.2.7.4 Extent of Decay

Armillaria root disease usually extends up the trunk for only a short distance and is approximately conical in shape. Often the defect affects only a portion of the scaling cylinder, not forming a "full circle" of rot.

4.2.8 Yellow Laminated Root Rot

Also known as Poria root rot, it is caused by *Phellinus weirii.*

4.2.8.1 Species Affected

Phellinus weirii is widely distributed throughout British Columbia and the Pacific Northwest and it attacks most coniferous tree species; hardwoods appear to be immune. Poria root rot is regarded as the most important disease affecting immature forests of Douglas-fir. It also occurs as a butt rot in mature conifers, particularly western red cedar and western hemlock.

4.2.8.2 Rot Description

This common butt rot in western red cedar enters the tree through basal injuries, particularly fire scars. It is a common rot in fallen trees and cull logs left in the woods. In the early stages, the wood shows a yellowish discolouration, which darkens as the wood become softer. The wood then begins to separate along the annual rings, and a definite ring shake develops. The thin layers of decayed wood usually have small elliptical pits parallel to the grain. Brownish strands of fungous tissue also appear between the layers. On ends of logs the rot may appear in crescent or ring-shaped circular areas with conspicuous radial cracking. The thin layers of decayed wood can be readily pulled out of the log. In older infections, the butt may become hollow. These hollows are usually lined with the typical laminated, decayed wood. Yellow ring rot also occurs as a heart rot of other conifers and may kill young Douglas-fir and grand fir as a root rot.

4.2.8.3 Indicators of Decay

On living trees the conks develop under roots, in root crotches, and in hollow butts. They are perennial, dark chocolate brown in colour, flat and crust-like, and rather soft and light.

4.2.8.4 Extent of Decay

Laminated root rot is usually confined to the butt log of western red cedar and rarely extends more than 2 or 3 m up the bole of living trees. However, it can extend 10 m or more in severe decay.

4.3 Heart Rots

Heart rot is confined to the interior of a log and often extends through the entire length of the log. Where the heart rot is visible at one end of the log only, the scaler must look for occurrences of rotten knots, conks (fungus fruiting bodies), log seams, scars, abnormal swellings (goiters), or other indicators to decide the extent of the rot.

It is easy to confuse heart rot with butt rot, but they are usually different in their make-up. For instance, butt rot is commonly caused by the velvet-top fungus *(Phaeolus schweinitzii)*and Annosum root rot *(Heterobasidion annosum).* The Indian paint fungus *(Echinodontium tinctorium)* and Aphyllophorales *(Phellinus pini)* cause heart rots. The organisms' manner of entry into the tree are different and so is the pattern of decay. Experience and training will familiarize the scaler with rot pattern characteristics occurring in the different species in a local area.

4.3.1 Red Fomes Rot

Red fomes rot is caused by *Fomitopsis cajanderi (Fomes subroseus)* or rose conk.

4.3.1.1 Species Affected

Douglas-fir, balsam (grand fir), western larch, Engelmann spruce, western white pine, lodgepole pine, yellow pine, juniper, and western red cedar.

4.3.1.2 Rot Description

Heart rot caused by rose conk generally enters the tree through broken tops, localizes in the top of the tree, and is often limited to the non-merchantable top portion. This top rot is most common in Douglas-fir. The rot also occurs in stumps, dead trees, and stored logs. A yellowish-brown to dark brown discolouration develops in the early stage of decay. The advanced decay is characterized by the formation of irregular, crumbly brown cubes. Thin whitish, or pale, rose-coloured fungous tissue sometimes develops in the cracks between the cubes of decayed wood.

4.3.1.3 Indicators of Decay

The conks of *Fomitopsis cajanderi* are perennial, woody, and bracket-like to hoof-shaped. The upper surface is brown to black and is usually cracked and roughened. The under surface has small circular pores, simply, rose-coloured, as is the inner tissue of the conks. Although old broken tops may indicate the presence of this rot, they are not a specific indication, as tops may also be invaded by other decay fungi.

4.3.1.4 Extent of Decay

Red fomes rot is usually confined to the top portion of the trunk but in lodgepole pine, this rot very often travels the full length of the trunk.

4.3.2 Brown Trunk Rot

Brown trunk rot is caused by *Fomitopsis officinalis*, or elephant foot conk, or quinine fungus (sometimes called *Fomes laricis* in older literature). It is also known as dry rot or red-brown heart rot.

4.3.2.1 Species Affected

Brown trunk rot most commonly affects western larch, Douglas-fir, and yellow pine. It also occurs in western white pine, Engelmann spruce, lodgepole pine, western hemlock, and balsam. Western Larch is the only species known to be attacked extensively. Hardwoods are not affected.

4.3.2.2 Rot Description

This rot is one of the major heart rots of living western conifers and continues its decaying action in logs and stumps. The fungus generally enters the heartwood through broken tops and branch stubs, and the rot is common in the upper and middle portions of the trunk. When basal scars are invaded, decay occurs in the butt of the tree. A yellowish to faint reddish-brown stain, or in the case of Douglas-fir, a purple discoloration marks the early stage of decay. The stain may extend for a considerable distance beyond the advanced decay. As decay progresses, the wood becomes softer and eventually breaks down into a crumbly mass of yellowish-brown to reddish-brown cubical chunks that are interwoven with extensive mats of thick whitish, resinous fungous tissue. On ends of logs, the early stages of decay appear in roughly circular areas of yellowish-brown to reddish discoloration. In the late stages, these circular areas show extensive radial and concentric shrinkage cracks filled with white mats of fungous tissue.

4.3.2.3 Indicators of Decay

Conks of *Fomitopsis officinalis* develop only after extensive decay in the heartwood. They are perennial, hard, and chalky; and after many years of development, they tend to be long and cylindrical in shape. The tissue is white, chalky, and tastes extremely resinous and bitter. The outer layers of tissue usually become greyish or black and extensively cracked, while the under surface is white with small pores. Broken tops often indicate the presence of brown trunk rot, although top injuries may be invaded by other decay fungi.

4.3.2.4 Extent of Decay

Sporophores (conks) are formed relatively frequently only on larch, but on all tree species a single conk indicates that most of the wood volume has been destroyed.

4.3.3 Red Rot

Red rot is also known as western red rot. This rot is caused by *Polyporus anceps.*

4.3.3.1 Species Affected

Red rot is a heart rot that occurs in yellow pine. It is also a slash rot in that species as well as in Douglas-fir, balsam, Engelmann spruce, western white pine, western red-cedar, and lodgepole pine.

4.3.3.2 Rot Description

Red rot is common in living yellow pine, entering mainly through broken tops and dead branches and causing a trunk rot in that species. It also causes a common slash rot of yellow pine and the other conifers listed. In the early stages of decay, the wood develops a reddish-brown discoloration. Later, small white pockets of advanced decay develop parallel to the grain. These pockets are usually poorly defined, have blunt or almost square ends, and tend to run together. Usually the wood between the pockets is considerably softer than firm wood; eventually the wood becomes a white spongy mass. In the heartwood, the rot typically develops in distinct radial zones from the centre of the tree; and this distinctive radial pattern on the ends of logs is characteristic of this rot. As decay progresses, however, the entire heartwood may be invaded; and this radial pattern will not be apparent.

4.3.3.3 Indicators of Decay

The conks do not ordinarily develop on living trees, but are usually present on stumps, decaying logs, and slash. They are annual, white, crust-like, and bracket-shaped; although rather tough, they usually deteriorate rapidly. On dead material, a conspicuous white mat of fungous tissue develops between the bark and the wood.

4.3.3.4 Extent of Decay

The extent of rot column will vary with the size of the timber and possibly from one locality to another. In advanced stages of decay, the defect affects the entire heartwood. In earlier stages of decay, the defect appears as a cylinder or hole. *Polyporus anceps*, sometimes called "wagon wheel" decay, is a common defect in spike top yellow pine. It is not uncommon to find this rot extending as much as 13 m downward into the trunk of the tree.

4.3.4 Redring Rot

Redring rot is caused by *Phellinus pini* (also called *Fomes* or *Trametes pini* in older literature). This rot is also called conk rot, red ring rot, ring scale, red heart, pecky rot, honeycomb rot, white pitted rot, and white pocket rot.

4.3.4.1 Species Affected

Phellinus pini has a wide distribution throughout the northern temperate zone and is one of the most common wood-destroying fungi in British Columbia. All conifers except junipers and Pacific yew are affected. It is particularly damaging in mature Douglas-fir, Sitka and northern white spruce, western hemlock, and balsam. This rot is also of importance in western white pine, yellow pine, lodgepole pine, western larch, and Engelmann spruce.

4.3.4.2 Rot Description

Red ring rot is primarily a heart rot of living trees. Decay may continue in dead standing trees or in fallen trees, but it is not an important factor in the decay of slash. The fungus usually enters the tree through branch stubs and causes a trunk rot. It may occasionally enter through basal scars, causing a butt rot. In the early stages of decay the wood shows a pinkish to purplish-red discoloration and, in cross sections of logs, often develops as a well-defined ring, hence the common name redring rot. As decay progresses, small, white, lens-shaped pockets develop parallel to the grain. The wood between these pockets is discoloured but firm. On ends of logs, the discoloration and pockets are often localized in crescent-shaped areas or in more or less concentric rings. Frequently, however, the pockets are uniformly scattered throughout the decaying wood with no definite pattern of arrangement. A pronounced ring shake may develop as a result of the rapid deterioration of the spring wood and the separation of the wood along the annual rings.

4.3.4.3 Indicators of Decay

The brownish, perennial conks of *Phellinus pini* usually develop at branch stubs or on basal scars. They vary from thin and bracket-shaped to thick and hoof-like. The under surface and margin of growing conks is a bright yellowish-brown with large irregular pores, and the upper surface is dark brown to blackish with concentric zones and furrows. Interior, grown punky knots usually indicate decay in the heartwood. The location of punky knots may be indicated by conspicuous swellings commonly called swollen knots. Where punky knots have healed over with no conspicuous swelling, they are revealed by chopping through the bark into the knot.

4.3.4.4 Extent of Decay

This rot is usually confined to the heartwood of all resinous species. In western white pine logs, the defect associated with a single conk or "punk" is generally confined to one-half the diameter of the scaling cylinder. In yellow pine and lodgepole pine, the defect extends through the entire diameter of the heartwood. No hard and fast rule can be consistently applied, inasmuch as the extent of decay on individual trees will vary with the age of the tree and the length of time that the fungus has been active in the tree. *Phellinus pini* in lodgepole pine often enters trees at points of damage or injury. The most common source of entrance is at the limbs or knots. In addition to its ability to destroy heartwood, *Phellinus pini* can attack sapwood and cause tree death.

4.3.5 Brown Stringy Trunk Rot

Caused by *Echinodontium tinctorium*, the Indian paint fungus is known to exist only in Japan and western North America and is distributed throughout coastal and interior forests. It is one of the most destructive wood destroying fungi in British Columbia and is the most common defect found in both grand fir and hemlock in British Columbia. The nature of the decay and pattern of spread of *E. tinctorium* can seriously reduce the value of the affected forest for saw timber because even in early stages it weakens the wood in a manner that causes separation along the annual rings (ring rot or laminated rot, where rings are closely layered with firmwood).

4.3.5.1 Species Affected

Brown stringy trunk rot affects primarily grand fir (balsam) and western hemlock. Sub-alpine fir (balsam) and mountain hemlock are also frequently affected, and Engelmann spruce and Douglas-fir are occasional hosts. Brown stringy trunk rot is reported in a few other British Columbia conifers, but it is important only in balsam and hemlocks. It does not occur in hardwoods. Although most coniferous tree species are attacked, inter-regional differences in its abundance seem to be related to major climatic features; differences within regions are related to specific habitats, some of which exclude the fungus while others favour it to varying degrees. The true firs (balsam) are highly susceptible throughout their range, western hemlock is moderately to severely attacked in specific habitats, but Douglas-fir and spruce are seldom attacked.

4.3.5.2 Rot Description

Brown stringy trunk rot, which is of major importance as a trunk rot of living balsam and hemlock, usually enters the tree through branch stubs or frost cracks. Decay of slash is of little importance as the fungus apparently does not invade dead trees and logs. The first visible evidence of decay in the heartwood is a faint yellowish or light brown discoloration or water soaked stain. In this stage, separation of the wood along the annual rings tends to develop, especially after drying. As decay progresses, the colour darkens; a definite ring shake develops, and rusty-red streaks appear in the wood. In the late stages of decay, the wood breaks down into a brownish stringy mass. In larger trees, the rot may destroy the entire heartwood of the trunk down to the roots and may extend into the heartwood of larger branches. Infections of long standing may leave portions of the trunk virtually hollow. On ends of logs, the decay is usually seen as a ring, a solid circular core of discoloured softened wood, or as a hollow lined with soft, stringy brown wood.

4.3.5.3 Indicators of Decay

Conks of *E. tinctorium* are perennial, woody, and generally develop under branch stubs. The upper-surface becomes blackened and extensively cracked. Coarse cream-coloured to greyish spines form the under surface. The interior tissue of the conk, including the spines, is a distinctive rusty-red in colour. Frequently the knots where conks develop show a similar rusty-red discoloration caused by the build-up of fungus tissue in the later stages of decay. These are known as "rusty knots." After the conks have fallen or have been knocked from the tree during logging operations, they provide a reliable indication of decay in the heartwood.

Whenever butt logs show shake and stain, the log should be thoroughly inspected for the fruiting bodies of this rot or rotten knots. Shake and stain are indicators of this defect. Because of the heavy water content the extreme butts on both balsam and hemlock, the rot does not break down the wood fibre as quickly as it does in the upper portions of the tree.

4.3.5.4 Extent of Decay

Refer to the discussion of conk following this section.

4.3.6 White Trunk Rot

Confined to deciduous trees, white trunk rot is caused by *Phellinus igniarius.*

4.3.6.1 Species Affected

White trunk rot affects trembling (quaking) aspen, paper birch, alders, and other hardwoods. This rot is not found in conifers.

4.3.6.2 Rot Description

White trunk rot is the most important rot of living hardwoods in British Columbia. The rot continues to develop in dead material and is often found on dead and fallen trees and stumps. Pale yellowish discoloured areas first appear in the early stages of decay. These discoloured areas are commonly enclosed in broad, brownish-black, or greenish-brown zones. Narrow black zone lines develop in the decayed wood, which becomes uniformly softer than firm wood. The decayed wood has no pockets or mottling and lacks any stringy or laminated structure. In the advanced stages of decay, abundant yellowish-brown fungous tissue may develop in the decayed wood. The fungus enters mainly through branch stubs, and the rot is usually located in the middle trunk. The rot is often found associated with stem cankers on aspen.

4.3.6.3 Indicators of Decay

The conks of *P. igniarius* are perennial, hoof-shaped, hard, and woody. The upper surface is blackish and extensively cracked, and the under surface is dark brown with very small circular pores. The inner tissue of the conk is dark reddish-brown. On aspen, the conks develop under branch stubs, or in the centre of stem cankers when associated with the disease called "black canker of aspen." Out-growths of black, clinker-like structures called "sterile conks" occur frequently at branch stubs. Punky knots are common indicators of white trunk rot and are conspicuous by their dark, brown coloured fungous tissue.

4.3.6.4 Extent of Decay

In advanced stages of decay, the centre heartwood of the entire log is affected by both *Hydnum abietis* and *Phellinus igniarius*. In earlier stages the decay remains firm and coloured (incipient rot), and no firm wood deduction is made.

4.3.7 White Stringy Trunk Rot

White stringy trunk rot is caused by *Fomes fomentarius.*

4.3.7.1 Species Affected

Fomes fomentarius attacks a number of deciduous species but is most common on birch. It causes decay chiefly in dead timber but can also attack living trees.

4.3.7.2 Rot Description

Decay first appears as a slight brown discoloration (spalting), the wood remaining quite firm. Wood with advanced decay is yellow-white, soft, spongy, and frequently contains brown to black zone lines. Small radial cracks filled with yellow filaments may develop, giving the decay a mottled appearance.

4.3.7.3 Indicators of Decay

The conks are perennial, woody or leathery, and usually hoof-shaped. The upper surface is zoned, grey to brown, or grey to black in colour, smooth and with a thick crust. The lower surface is brown and porous; the pores are small and regular in outline. The body tissue is brown. Conks form on standing trees and on slash.

4.3.7.4 Extent of Decay

As with the other heart rots, the amount of decay is usually determined through observation of cut ends of the log. Unfortunately, conks are knocked off before the scaler has an opportunity to look for them.

4.3.8 Long Yellow Pitted Trunk Rot

Long yellow pitted trunk rot is caused by *Hericium abietis.* This rot is also known as long pitted trunk rot and long pocket rot.

4.3.8.1 Species Affected

Hericium abietis is responsible for a frequently occurring butt and trunk rot of western hemlock and balsam and is known to attack Sitka and Engelmann spruce.

4.3.8.2 Rot Description

This rot occurs frequently in the heartwood of living balsam and hemlock and is common in stumps, snags, and fallen trees. It also continues to develop in stored logs. In the early stages of decay, the wood, which remains firm, develops a yellow or pale brownish discoloration and often appears mottled with darker spots. As decay progresses, elongated pockets develop parallel to the grain. These pockets may be empty or may be partially filled with whitish or yellowish fibres of decayed wood. The wood between the pockets is discoloured but firm. On the ends of logs, the decay pattern is irregular; in the early stages, it appears as brownish discoloured areas, roughly circular in outline. In the advanced stage of decay, the pockets are visible in the discoloured areas.

4.3.8.3 Indicators of Decay

The white, coral-like, annual conks develop on living trees, stumps, slash, and on ends of recently cut logs. They are soft, extensively branched, and bear large numbers of pendant spines or teeth. Because of their soft, fragile consistency, these conks deteriorate very rapidly and are present as indicators for a relatively short period of time.

4.3.8.4 Extent of Decay

Yellow pitted trunk rot is generally confined to the bottom portion of the tree. Very little is known about the extent of decay caused by this fungus, but it is included here because of its common occurrence in hemlock and balsam (grand fir) in British Columbia.

4.3.9 Red Heart Rot

This is a common and important decay producing fungus of conifers in British Columbia caused by *Stereum sanguinolentum* or bleeding fungus (conk).

4.3.9.1 Species Affected

Red heart rot is responsible for extensive heart rot in mature pine, northern white and Engelmann spruce, and in balsams. In other hosts it is largely a slash-destroyer, although it may occasionally be responsible for heartwood stain and terminal die-back following entry through pruning wounds, logging scars, and lesions formed as a result of climatic injury. Until recently, the fungus was believed to gain entrance to trees chiefly through dead branches. Recent evidence, however, suggests that wounds may be more important as infection courts.

4.3.9.2 Rot Description

The incipient stage of decay in red heart rot is firm and appears as a red-brown heartwood stain. In the advanced stage, the wood becomes light brown to red-brown and soft and friable in texture. Thin, white mycelial fragments may develop in association with advanced decay. Finally, the wood becomes a brown, fibrous, stringy mass.

4.3.9.3 Indicators of Decay

Conks are common on the lower surface of fallen dead branches and on log ends, but they are rarely found on dead standing trees. They are annual, leathery, and flat or turned up at the margins, often forming thin, crust-like layers. The upper surface is grey to light brown and zoned. The lower surface is roughened, grey to light brown turning blood red when bruised, hence the common name, "bleeding fungus." Their small size, inconspicuous coloration and rare occurrence renders their presence of limited value as indicators of decay in living trees.

4.3.9.4 Extent of Decay

The extent of decay from red heart rot is variable, and not to be confused with stain. The extent of rot may be observed at the cut ends of logs.

4.3.10 White Mottled Rot

White mottled rot is caused by *Ganoderma applanatum* or Artist's conk, so named because the white underside of this fungus is excellent to draw on.

4.3.10.1 Species Affected

Ganoderma applanatum attacks a wide range of coniferous and deciduous hosts. It causes an important decay of dead trees but may gain entrance to living trees through wounds, causing extensive damage.

4.3.10.2 Rot Description

In the early stage of decay, the affected wood of most species becomes bleached and is encircled by a dark brown stain. In western hemlock, this stage is violet to lilac in colour. In the advanced stage, the wood becomes white, mottled, and spongy. Black zone lines may or may not be present.

4.3.10.3 Indicators of Decay

The conks (sporophores) are perennial, leathery to woody, and tend to be flat or plate-like. The upper surface is light brown to grey and deeply zoned. The margin, when fresh, may be white. The inner body is light brown but may possess a light grey zone. The lower surface is white, turning brown in old specimens or when bruised or marked, hence the common names "picture fungus" or "artist's conk."

4.3.10.4 Extent of Decay

The ends of cut logs may be observed to determine the extent of decay.

4.3.11 Conks, General

Conk is the common name for the fruiting bodies of decay fungi that infect the inside of a tree. Airborne spores produced by the fruiting bodies are the main agents for the spread of decay fungi. Infections are initiated through branch stubs and various kinds of stem or branch wounds caused by such things as animals, machines, lightning, and windfalls. Also, the *Armillaria* and *Tomentosus* family of root and butt rot can spread through soil or by root contact, but are not normally the types of rot to be hidden in a log. Although there are many different heartwood fungi, the *Phellinus igniarius* family are the most important trunk decay pathogens in northern hardwood forests, causing extensive damage in birch, maple, alder, willow, aspen, and cottonwood.

For the scaler, a knowledge of the characteristics of the fungi will provide valuable information on what to expect from these organisms. The *location* of decay (heart rot, sap rot, or butt rot), *pattern* of decay (pocket rot, stringy rot), and *type* of decay (white rot, brown rot), are different among the decay organisms. Therefore, the appearance of conks on the surface of a log that appears firm on both ends will no doubt indicate the presence of rot not visible to the scaler. This will give the experienced scaler a good idea of what to expect for the range of the decay within the log.

Conk rot is indicated by the fungal fruiting bodies (a conk) and/or rotten knots (conk knots). Conk rot is an external indicator of internal decay and may show as heart rot at one or both ends of the log, or may show simply as rotten knots. Some indicators are swollen knots where branches were shed many years earlier (blind conk), irregular bulges with exuding resin (goiter), resin flow from knots, and brown fungus parts (basidioscarps) at branch bases, branch stubs, knots, wounds, and cracks. "Punk knots" are included in this definition and are common in Douglas-fir, western larch, pines, and some spruces. A punk knot is a mass of brown fungus parts (hyphae)that extend from a decayed branch stub within the trunk to a local swelling on the surface, appearing like a blackened knot. Swelling is from a slight overgrowth of wood around the punk knot. Typically, dark yellowish brown to reddish brown fungal tissue is exposed where a punk knot is cut.

The extent of rot can range from a single rotten knot to extensive heart rot. The amount of rot in a log with conk is determined by the location, quantity, and species of the fruiting bodies, and local experience will allow the scaler to make accurate assessments of decay.

When conk rot shows only at one end of a log as heart rot, the presence of conk knots can indicate how far up the log the rot occurs.

Where conk rot shows at both ends of a log, refer to the methods already given in the heart rot section for through running heart rot.

Unfortunately, for those who are interested in the identification (morphology) of conks, logs delivered to a mill yard seldom maintain their conks because equipment handling removes them. The indicator then becomes a "conk knot" which is simply a rotten knot often showing fungus parts.

Because of the variability of the effects of conk, not only by fungus species but by the tree species and location around the province, it is very difficult to establish with conviction any conventions that apply across the province. Local conditions and experience will therefore determine which conventions or "rules of thumb" may be applied with conviction. The local Forest Service scaling representative will assist new scalers in making these judgements. Where there are conk knots and no sign of rot at the ends of a log, the scaler should, if possible, observe the processing of the log in order to get a better idea of the internal effects of conks.

4.3.12 Rotten or Hollow Knots

Rotten or hollow knots (limbs), other than indicators of *Phellinus pini* or *Echinodontium tinctorium* (punk knots) and *Fomitopsis officinalis,* are encountered frequently in yellow pine, and occasionally in other species. Their reliability as indicators of either the presence or extent of decay is extremely variable between timber stands. Such knots have a rotten core within the heartwood of the limb, which may be associated with a pocket of rot within the heartwood of a log or, in some instances, be confined to the limb. The appearance of log ends that have been bucked through, or adjacent to such knots serve as good evidence of the probable effect of similar knots on the same log. Observations of a number of such log ends will aid the scaler in establishing a pattern of general characteristics for the particular timber stand and species being scaled. The normal course of log presentation restricts the number of meaningful observations that can be made and, where opportunity is afforded, logs should be intentionally bucked through such knots or observed while being milled for additional evidence of a general rot pattern. Generally, the pie-cut or sector method of deduction or, depending on the observed characteristics, another appropriate method may be used as described in Chapter Five, Firmwood Deductions.

4.3.13 Pipe or Pocket Rot, General

Pipe or pocket rot is often caused by fungus such as *Phellinus pini.* It infects most conifers in North America, with balsam, hemlocks, yellow pine, cypress and western red cedar commonly affected. Decay is usually in one column or several discrete columns that extend from branch stubs, where the disease starts. Wood in early stages of decay will have small pockets which slowly expand and merge into pipes or columns.

Pipe or pocket rot is defined as interior decay, other than butt rot, ring rot, or cylindrical heart rot, that frequently occurs at several locations of the same cross section of a log. Because this type of rot does not necessarily conform to the circular shape of the other rots described (e.g., butt rot, heart rot, sap rot), the scaler can use the "rectangular box" deduction method for these and many other kinds of defects that have a cubical or rectangular shape.

Each segment of decay is scaled either as a rectangular solid (i.e., cubical) or as a cylinder.

Where multiple pockets of rot are present, add the rot volumes together to calculate the total rot volume.

When the shape of the pocket is circular, refer to the heart rot section for the deduction methods.

4.3.14 Ring Rot, General

Ring rot is actually a form of heart rot where decay follows the growth rings but leaves a core of firm wood. The cylinder formula is used to calculate the volume enclosed by the outside diameter of the ring and to calculate the volume enclosed by the inside diameter of the ring. The inside volume is subtracted from the outside volume to find the volume of the rotten ring.

4.3.15 Goiter

Goiter is a swelling or abnormal growth on the bole of a tree; rot may be associated with this defect. Internal rot seldom travels more than 1 m above and below the goiter. Firm wood loss is based on scaler experience and judgement.

4.4 Sap Rots and Stains

Sapwood on logs cut from dead trees (snags or windfalls) is often in advanced stages of decay. If rotten sapwood extends over both the length and circumference of the log and the sapwood is still in place, the gross or outside diameter will be measured directly and the average diameter determined just as for green logs to obtain the gross volume. When the rotten sapwood has sloughed away, the gross or outside diameter will be determined by measuring the firm wood within the sapwood and adding the estimated thickness of the rotten sapwood. To obtain net scale, determine the average diameter of the firm cylinder inside the rotten sapwood (or surface checks) and treat it as a special scaling cylinder, considering any other defects that may be present. The difference between the gross scale of the outer scaling diameter and the net scale of the inner scaling diameter will be the deduction if no other defects are present.

Although living sapwood is relatively resistant to decay, certain fungi (*Daedalea unicolor* for example), is a common decayer of sapwood. It also colonizes living trees weakened by environmental stress. Several canker-rots (*Trametes versicolor, Schizophyllum commune, and Inonotus obliquus*) are widespread and infect living hardwoods (birch, cottonwood, aspen, and maple), eventually killing the tree.

Examine logs with dead sapwood carefully. Rot may extend into the heart in the form of pockets. In fire-killed or down timber, these pockets maybe on one side only. A large proportion of the scale volume of a log is in the outer few centimetres of wood. The outer 25% of a log contains 75% of the volume, so a relatively small error in measuring the amount of rotten sapwood may lead to a sizable error in the actual firmwood content. In some cases though, the identification of rotten sapwood becomes a problem. During the decay process of the wood, it is often quite difficult to distinguish between firm sapwood and infirm sapwood; the following indicators may serve as a guide for the scaler to warrant closer observation:

- Black sapwood from end to end of the log,
- Brown pockets of rot (more evident in fresh logs),
- Sapwood soft and separated from the heartwood,
- Conks of sap rot fungi on logs,
- Dark blue stain (probably in association with brown rot), and
- Bark loosened or completely shed.

4.4.1 Blue Stain or Sap Stain (Also Black Stain Root Disease)

Blue stain is caused by a large number of fungi, including species of *Ceratocystis, Graphium, and Leptographium.* Sapwood of virtually all species may be stained to some extent, but western white pine, yellow pine, lodgepole pine and Engelmann spruce are particularly susceptible. Blue stain in logs is not considered a defect for which deduction should be allowed, as firm or firm blue-stained lumber is merchantable. No deduction should be made in scaling logs affected with blue stain, unless the sapwood is broken down or rotten. In the latter case, the decay can be traced to some of the true wood-destroying fungi. The conditions favourable for the development of the bluing fungi - high moisture content and warm weather - are also highly favourable to the development of the true wood-destroying fungi; hence logs attacked by bluing fungi may at the same time be attacked by various fungi-producing decay. In scaling blue-stained logs that have broken down or rotted in the sapwood, a deduction must be made however, and such logs should be scaled to the average diameter inside the rotten sapwood.

Losses from surface checks may be scaled out in the same fashion, but this is a grading consideration rather than a scaling consideration because checks do not produce a significant firm wood volume loss.

4.4.2 Brown Crumbly Rot

Brown crumbly rot is caused by the red belt fungus or *Fomitopsis pinicola*, formerly *Fomes pinicola*.

4.4.2.1 Species Affected

The red belt fungus is one of the most frequently occurring decay-producing fungi in British Columbia, attacking a wide range of coniferous and deciduous tree species. It is very common on dead trees and has been termed the scavenger fungus because of its importance in reducing wood to forest litter. It occurs frequently as a sap rot, but can also gain entrance through wounds and cause considerable damage to the heartwood of living trees.

4.4.2.2 Rot Description

This rot is probably the most important slash rot of conifers in British Columbia. It occurs on dead standing trees, fallen trees, sawlogs, and pulpwood in storage. The rot usually develops in the sapwood, which is decayed rapidly, and then progresses into the heartwood. It has been reported as an occasional heart rot in living trees, entering the heartwood through basal scars; but its major role is in decay of slash and stored logs. The early stage of decay is marked by a faint brownish discolouration. In the later stages, the wood is reduced to a yellowish brown to reddish brown mass of cubical chunks with white mats of fungous tissue developing in the cracks in the decayed wood. The sapwood of dead spruce and pine is destroyed quite rapidly; where logs of these species are kept in decks for long periods, the losses in higher grades of lumber or pulp yields may be considerable.

4.4.2.3 Indicators of Decay

Conks of *F. pinicola* develop readily on dead standing and fallen trees and on stored logs. They are perennial, woody, and hoof-shaped to rather thin and bracket-like. The upper surface is crusted, grey to blackish, and often has a distinct reddish band around the margin. The under surface is smooth and cream-coloured with very small, circular pores. Small, whitish, crust-like conks often develop extensively over the sapwood on ends of decaying stored logs.

4.4.2.4 Extent of Decay

Because sapwood is vigorously attacked by this rot, scaling is generally accomplished by scaling inside the affected sapwood.

4.4.3 Brown Cubical Sap Rot

Many fungi cause a brown cubical sap rot but those most commonly found are caused by *Lenzites saepiaria*, *Trametes americana*, and *Trametes serialis*.

4.4.3.1 Species Affected

All commercial conifers and many deciduous species in British Columbia are affected by this rot and it is commonly associated with deterioration of fire-killed trees and slash. *Lenzites saepiaria and Trametes serialis* are occasionally found on living trees, on dead sapwood under fire scars, and on other wounds.

4.4.3.2 Rot Description

The decay first appears as a yellow to yellow-brown discoloration in the sapwood or outer heartwood. Advanced decay is characterized by a mass of crumbly, brown cubical wood that may or may not have thin mats of fungous tissue in the cracks in the wood. Decay on fallen trees, stumps, snags, and smaller material on the ground usually begins in the sapwood, which is rapidly destroyed, and progresses into the heartwood, which is also eventually decayed.

4.4.3.3 Indicators of Decay

Conks of these fungi are annual, tough, and persistent. *Lenzites saepiaria* conks are light to dark cinnamon brown, thin, and bracket-like, and have radial gills on the under surface. *Trametes americana*, which are similar, have large circular pores on the under surface. *Trametes serialis* conks are white, flat, and crust-like with large circular pores.

4.4.3.4 Extent of Decay

Brown sap rot indicates that the entire sapwood is unusable for lumber or pulp and that the log should be scaled inside the defective sapwood.

4.4.4 Grey-brown Sap Rot

Grey sap rot is caused by *Cryptoporus volvatus* or pouch fungus.

4.4.4.1 Species Affected

Extremely common in fire-killed Douglas-fir, it also invades balsam (grand fir), Engelmann spruce, yellow pine, western hemlock, and western larch.

4.4.4.2 Rot Description

Grey-brown sap rot develops very rapidly in dead standing trees and is common in recently-cut stored logs, particularly grand fir logs and pulpwood. The rot is generally superficial, being limited to the outer 6 mm of sapwood. Dark grey streaks and flecks appear in the wood, which remains quite firm.

4.4.4.3 Indicators of Decay

Conks of *Cryptoporus volvatus* usually appear on trees the year after death occurs, often developing by the thousands over the entire trunk surface as well as on the larger branches. These conks indicate the rapid and extensive development of the decay in the newly-dead sapwood. Apparently, conks develop during one season, are quickly eaten by insects, and do not occur again on that particular tree. They are cream-coloured and often resemble small eggs or pouch-like structures attached to the bark of a tree. Larger conks, up to 5 cm in diameter, are more or less hoof-shaped. The underside of the conk has a small circular hole near the base, opening into a cavity that frequently contains insects that spread the spores of the fungus.

4.4.4.4 Extent of Decay

Because of the superficial nature of this rot, no deduction is made unless the sapwood is broken down. If the sapwood is broken down, deduction should be made by scaling inside the affected area.

4.4.5 Pitted Sap Rot

Caused by *T. abietinum* or purple conk, this rot is also known as hollow pocket rot.

4.4.5.1 Species Affected

Virtually all conifers in British Columbia are invaded by this rot with the possible exception of junipers and Pacific yew. It is of primary importance as a deteriorating agent but it is also capable of causing sap rot and heart rot in living trees. It has been reported to have attacked unseasoned wood after manufacture into lumber.

4.4.5.2 Rot Description

Pitted sap rot usually attacks only dead material and is one of the most common decay fungi on stumps, logs, and slash in the woods, it also develops on decked sawlogs and pulpwood. Occasionally it decays dead sapwood on cat faces of living trees. T. *abietinus* does not cause heart rot of living trees, although heartwood on dead material may be decayed. The first evidence of decay is a yellowing and softening of the wood. Tiny empty pockets that are elongated parallel to the grain appear. As decay progresses, these pockets become larger and more numerous until the wood has a fragile, lace-like appearance. Pitted sap rot develops rapidly in wood that still has bark on it.

4.4.5.3 Indicators of Decay

Conks of *T. abietinus* usually develop abundantly on decaying material. They are flat and crust-like on the under-surface of logs and slash; and they are thin and bracket-shaped on dead standing trees, stumps, and the upper surfaces of down material. The conks are grey with faint radial zones on the upper surface and purplish with large, irregular pores on the under surface. As the conks age, the purple colour fades to a pale brown. On the sapwood at the ends of logs, the conks commonly appear in large numbers, sometimes completely covering it.

4.4.5.4 Extent of Decay

As conks develop readily on the bark over the entire surface area of the decaying sapwood, the distribution of the conks usually indicates the extent of decay. Sapwood of logs on which conks of T. *abietinus* appear is considered unfirm and should be deducted for accordingly. Such logs are scaled inside the affected sapwood.

4.5 Other Natural Defects

Surface defects take a variety of forms, showing up as either rotten and charred wood or missing wood such as catface, deadside, and miscellaneous scars.

Due to the nature of these defects, it is necessary to use judgment in determining the best deduction method to use. In some cases, a diameter reduction is made, as with sap rot. In others, the shape of the defect, cylindrical, conical, or cubical determines the best method to use. Often, very little volume is involved and no deduction can be made because the smallest volume deduction increment possible is 0.1 m.

With experience, it will become clear that many forms of defect will suit a shape for which a calculation method has already been described in the Measurements and Deduction sections of this scaling manual.

If the defect extends to the pith, scale as a sector of an arc or pie shape.

If the defect does not extend to the pith, scale as a portion of a cylinder, portion of a cone, or by "squaring up" the defect.

Portions of defects outside the scaling cylinder are not measured (i.e., flared portion of a log).

The following list illustrates many typical natural defects that involve missing wood.

4.5.1 Cat Face - Fire Scar

A depression in the outer surface of a log where the tree failed to renew following an injury, such as an abrasion or fire scar.

4.5.2 Dead or Missing Side

Dead side is decay extending from the surface to the pith of a log, resembling a pie shape in cross section of the log.

4.5.3 Lightning Scar

Lightning can damage a tree enough to provide entrance of fungal spores or cause other structural defects.

4.5.4 Fire Scar, Burn Saddles

Fire scars take several shapes, usually affecting the outer surface of the tree. Burn saddles are saddle shaped pockets burned into a stem where two trees lay diagonally across each other in a fire.

4.5.5 Bark Seam

Seams are longitudinal separations of fibre in a living tree. They are often caused by lightning, wind, frost (check), other injuries, or simply growth characteristics (fluted cedar, forks, etc.). A patch of bark will be partially or wholly enclosed by the wood, and rot may be associated with it.

4.5.6 Worm Holes, Insect Damage

Insect burrows that are sufficient to result in a significant loss of firmwood are not common in healthy trees. However, storage for long periods in salt water allows teredo borers to do extensive damage and storage in land decks can allow boring insects to infest the sapwood. Lumber loss can be significant if the damage is extensive enough to affect merchantability.

4.5.7 Burls

Burls are abnormal swellings of the main stem or branches and are among the most conspicuous of the stem diseases. They vary considerably in size, reaching 1 m or more in diameter in some cases but rarely occur in sufficient abundance to warrant concern. Burls result from the abnormal development in number or size of wood cells following disturbance to the cambial layer, the cause of which in most cases remains unknown. Dwarf mistletoes cause burls in several coniferous species. Because of their size, burls will add volume to a log but are unsuitable for manufacturing lumber. Although they can affect the quality of underlying wood, it is not significant enough to warrant a grade deduction. In fact, burl wood and surrounding wood can demand premium market prices depending on species because of the very appealing grain structure revealed in specialty products manufactured from it, such as automotive trim veneers and furniture.

4.5.8 Galls

Galls are localized trunk or branch swellings in which bark tissues are mainly affected with little or no damage to the underlying wood. Small galls, approximately 1 to 3 cm in diameter are relatively frequent on Douglas-fir and western hemlock, those on Douglas-fir have been attributed to a bacterial agent but in western hemlock the cause is still unknown. Because of their minimal effect on volume or wood quality, galls are ignored in scaling.

4.5.9 Cork Bark

Cork bark is an unusual condition of bark-ridging sometimes encountered in balsam (Sub-alpine fir). Restricted areas of the main stem, seldom exceeding 1 m in length, are affected. The condition is characterized by a very thick and deeply furrowed bark, contrasting sharply with normal, relatively smooth bark. Studies have shown that wood quality is adversely affected, and may be a consideration when determining grade. It is important for the scaler to allow for the increased bark thickness when calipering a log to obtain a diameter inside the bark.

4.5.10 Witches Brooms

Witches brooms occur on a number of tree species and are characterized by a ball of very densely intertwined branches high on the tree, often looking like a shaggy bird's nest. Mistletoe, rusts, and needle diseases cause brooming; other brooms of unknown cause occur, sometimes very large and involving much of the tree crown. Because brooms seldom, if ever, arrive in a log scaling yard, they are not considered in scaling or grading.

4.6 Mechanical Defects

Regardless of how efficiently or carefully the logging process is conducted, it will result in some damage to trees when they are felled, bucked, transported, and handled by various mechanical devices. In many instances, this damage will result in a considerable loss of firm wood; hence the scaler must be able to recognize and make proper allowances for the various types of mechanical defects. Log storage over long periods will cause defects such as sap rot in dryland decks and toredo borings in log booms.

It is important to perform a scale as soon as possible after harvesting to avoid the problems of determining whether a defects are natural or induced by storage. There are two different appraisal systems in place in British Columbia, and the approaches to scaling and grading for mechanical defects differ depending on the method of appraisal. It is necessary for the scaler to contact the Forest Service Scaling Representative for instruction on the correct approach. Typical mechanical defects are discussed in the following subsections.

4.6.1 Undercut

A heavy undercut in a butt log will reduce the amount of wood available to cut lumber but no firmwood deduction is made. The preferred undercut is the "Humbolt cut" where the wedge of wood is cut out of the stump instead of the butt log, improving utilization. Mechanical harvesting methods do not have an undercut but there may be some shattering if the felling machine is not functioning properly.

4.6.2 Barber Chair or Slabbed Logs

Barber chair is a very dangerous occurrence, where the tree splits up the trunk from the hinge during the felling process. The handling process can split or "slab off" logs, such as a tree bound up during skidding or split while being handled in the landings or yards. Heavily leaning trees may also cause this defect when felled. A common deduction method is to use the cylinder formula and apply a factor representing the missing wood. Refer to the Measurement Section of this manual for methods of obtaining the net volume of slabbed logs.

4.6.3 Shatter or Broken End

Shatter is another defect resulting from the handling process and is caused by the same factors that cause slabbing. When felled, a tree will often break or shatter if the stem hits a rock or other object and also can be broken during skidding, decking, loading, or unloading. Shattered ends are usually bucked clean but will often show up in a scaling yard. The Measurements Section of this manual will provide the scaler with the correct techniques for measuring the lengths of logs with broken ends.

4.6.4 Stump or Sliver Pull

A defect associated with felling caused by a portion of the wood in the butt log being left on the stump, or a portion of the stump being left on the butt log. If the sliver pull is out of the butt log, an actual loss in volume occurs and may be significant enough to deduct from the gross volume by using the "rectangular box" formula. If the sliver is out of the stump, there will be a volume increase, but in practice these are never scaled. The faller or bucker will usually remove these pieces or "snipes" for safety reasons immediately at the logging site, so they will rarely show up in a scaling yard.

4.7 Multiple Defects

Disease, environmental damage and equipment damage will all affect the volume of firm wood in a log. Often, these defects are combined on one log, such as catface and heart rot, missing wood, and butt rot, requiring the scaler to use two or more methods to obtain the net volume. It is also quite possible for the defects to overlap, so a scaler may have to use different methods to obtain the net volume. Where overlap occurs, the scaler must ensure that a deduction will not be made twice in the overlapping area.

Acknowledgement

The B.C. Forest Service wishes to express its appreciation to Dr. Eric Allen of Forestry Canada for contributing the photographs which make up Section 4.8.

4.8 Illustrations of Common Fungal Organisms

Figure 4.1 Brown cubical butt rot (Phaeolus schweinitzii) in pine.

Figure 4.2 Tomentosus root rot (Inonotus tomentosus) in pine.

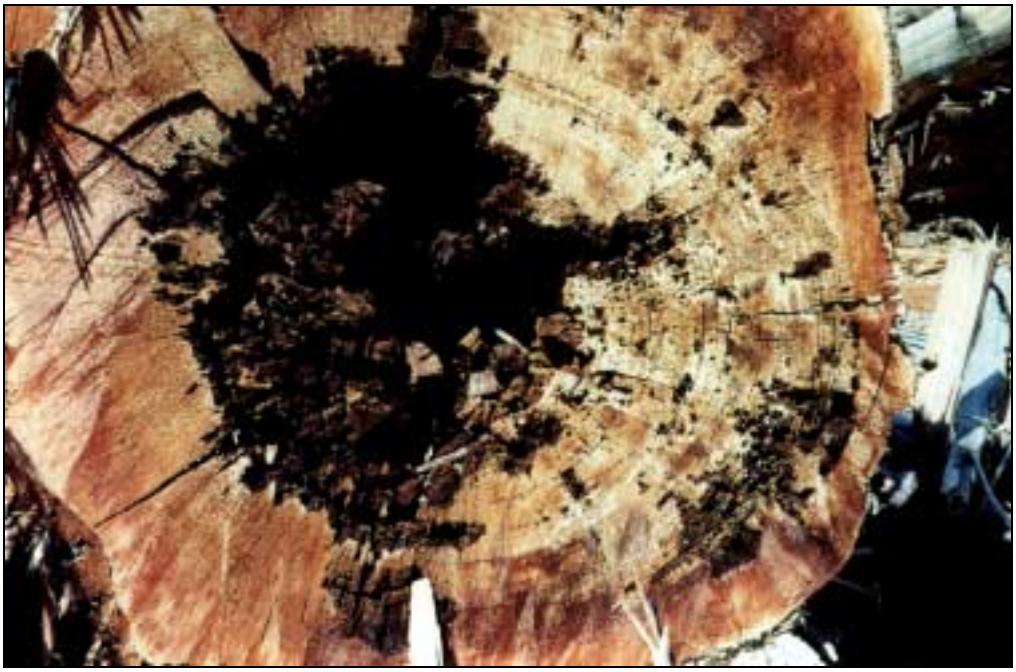

Figure 4.3 Cedar pocket rot (Postia sericiomollis). It is found both as a butt rot and a heart rot.

Figure 4.4 Brown stringy trunk rot (Echinodontium tinctorium), incipient stage.

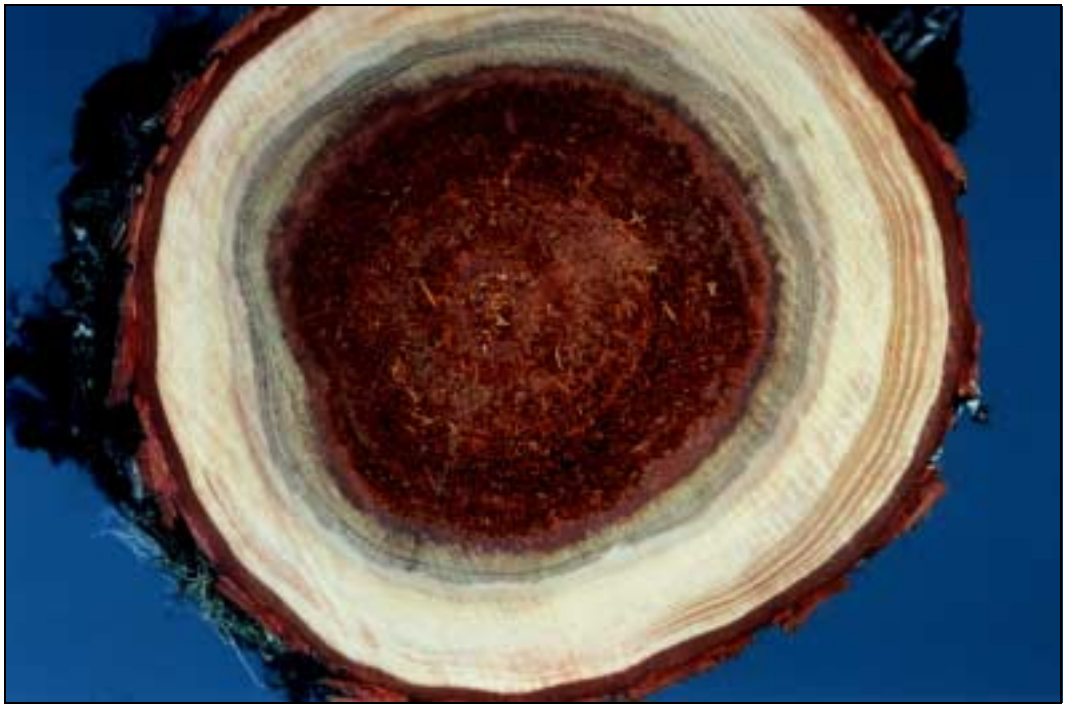

Figure 4.5 Brown stringy trunk rot, advanced stage.

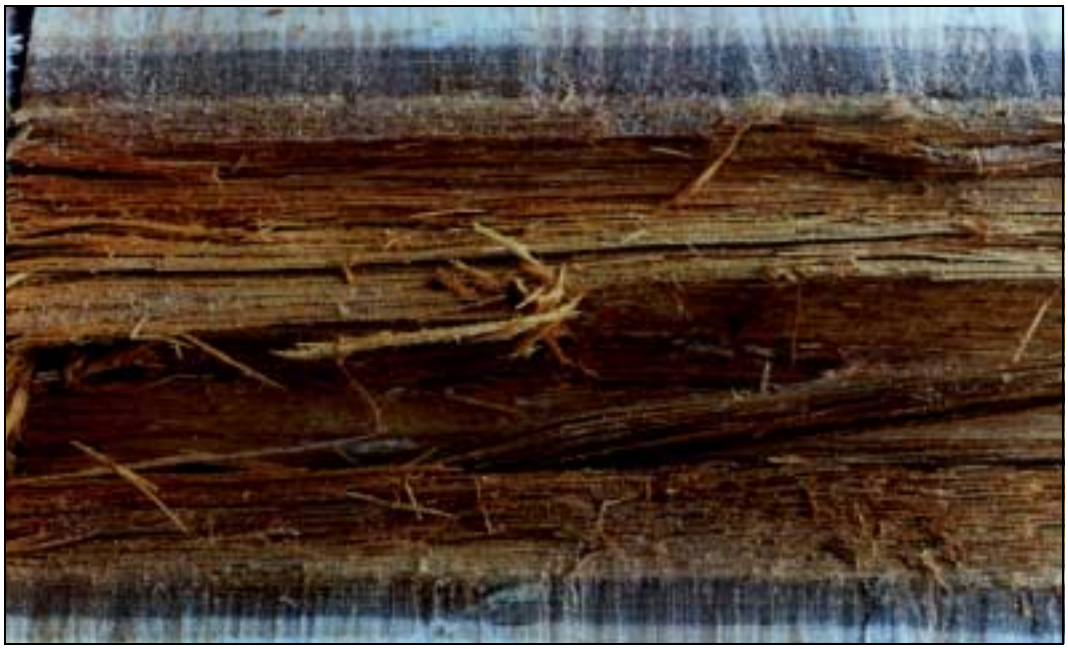

Figure 4.6 Brown stringy trunk rot, cross section.

Figure 4.7 The notorious Indian paint fungus (Echinodontium tinctorium), responsible for Brown stringy trunk rot.

Figure 4.8 Aspen trunk rot (Phellinus tremulae), indicating the relationship between the heart rot and the fruiting body (conk).