STEM DECAYS

State Forester Forum

Introduction

Wood decay is caused by fungi that use the woody cell wall material as a food source. These fungi inhabit and break down the heartwood of living trees, and both the heartwood and sapwood of dead trees. With the exception of several root decay and sap rot fungi, decay fungi do not attack living tissue. They break down the wood, producing a decay characteristic of the fungus. All conifers and broad-leaved trees are susceptible to decay organisms. Some decay fungi are restricted to one, or a very few tree species, while others attack a wide range of species.

Wood decay organisms are an important factor in forest ecosystems because they:

- Remove woody debris from the forest thereby reducing the buildup of fuels and the risk of fire.
- Recycle nutrients that are often in short supply in forest ecosystems.
- Add beneficial organic matter to the soil.
- Provide habitats for small mammals, birds, and insects.
- Cause significant losses of merchantable volume in older stands.

Damage

Wood decay fungi cause damage by:

- Decaying roots and butts, causing mortality and windthrow.
- Weakening tree stems and predisposing them to snow and wind breakage (Figure 1).

Figure 1. *Stem breakage resulting from advanced decay. Photo: U. S. Forest Service.*

- Destroying and degrading valuable sawtimber.
  —Heartrot is most common in older trees where the fungi can cause more loss of sawlog volume than all other diseases combined.
- Degrading sapwood in dead trees and trees attacked by bark beetles and wood-boring insects.
  —The loss of sapwood can reduce merchantable volume by one third.

Tom Schultz
Director
Idaho Department of Lands
300 N. 6th Street, Suite 103
Boise, ID 83720
Phone: (208) 334-0200

Insect and Disease

No. 12

September 2014

Craig Foss
Chief, Bureau of Forestry Assistance
Idaho Department of Lands
3284 W. Industrial Loop
Coeur d'Alene, ID 83815
Phone: (208) 769-1525

Biology

Causal Organism:

Identification of the most important decays and the fungi that cause them are covered in separate Forester Forums. Descriptions of additional decays can be found in:

- "Field Guide to Diseases and Insect Pests of Northern and Central Rocky Mountain Conifers" (Hagle *et al*. 2003)
- "Field Guide to the Common Diseases and Insect Pests of Oregon and Washington Conifers" (Goheen and Willhite 2006)
- "Idaho Department of Lands Log Scaling Handbook"
- "Major Decays in the Inland Northwest" (Partridge and Miller 1974).

Disease Cycle:

Stem decay organisms can be roughly classified as to whether they primarily attack the heartwood of living trees or the heartwood or sapwood of dead trees and branches. Sapwood is the layer of wood inside the bark and cambium that contains living xylem cells and is physiologically active. The width of the sapwood varies with species and tree vigor. Heartwood is non-living and develops in the center of the tree as the tree grows. Depending on species, the heartwood is often a darker color than the surrounding ring of sapwood.

Figure 2. *Heart rot in grand fir caused by the Indian paint fungus (Echinodontium tinctorium).*

Heartrot fungi attack the heartwood cells of living trees (Figure 2). These fungi do not invade sound trees but gain entrance to living trees when wind-disseminated spores come in contact with heartwood exposed by wounds, broken tops, logging and fire scars, or dead branch stubs.

Figure 3. *Sap rot in a Douglas-fir log from a tree attacked by bark beetles.*

Sap rots (Figure 3) develop after the tree dies or in conjunction with the attacks of wood-boring insects. Many wood-boring insects have the ability to carry decay fungi from the tree they developed in to the tree they are attacking. The fungi then begin to grow and attack the sapwood. Another form of sapwood decay results from root decay fungi that attack roots and kill the living portion of the root and eventually kill the tree. Root decays are covered in separate Forester Forums.

As the decay fungi grow through the wood, they produce enzymes and other substances that decompose the cell walls of the tree. These decomposition products are the food source absorbed by the fungus. This decomposition process reduces the strength of the wood and predisposes the tree to stem breakage. When the tree dies, heartrot fungi can then attack the sapwood. Most (but not all) heartrot fungi cannot survive as the wood of the dead tree dries out and are replaced by other decay organisms. Sapwood decay will continue to degrade sapwood after the tree dies and will also continue in cut logs delivered to the mill. Sap rots that attack the stem do not as a rule attack the heartwood.

Distinctive conks or fruiting bodies are produced on the tree as the decay progresses. Conks are fungal growths on the outside of trees and logs. They are the reproductive structures of the decay fungi and are important for identifying the particular species.

Conks may be hoof-shaped or shelf-like (Figure 4) or grow flat like a crust on the surface of wood or bark (Figure 5).

Figure 4. *Shelving conk of the red belt fungus (Fomitopsis pinicola).*

These are often formed on the bole under or on dead branches. Spores are produced on the underside of the conk in small pores or on teeth or gills depending on the fungus species.

Figure 5. *Crust-like conk of the laminated root disease fungus (Phellinus weirii).*

These spores spread the fungus to other trees. Conks can produce as many as 100,000 spores per square millimeter of pore surface daily.

The Decay Process:

Woody cells have thick walls composed primarily of cellulose, hemicelluloses, and lignin. Decays can be classified based on the way they degrade the wood.

Brown rot fungi primarily decompose cellulose and hemicellulose, leaving much of the brown-colored lignin (Figure 6). The loss of the cellulose fibers allows the decayed wood to fracture cross-grain, resulting in a cubical, crumbly appearance. These fungi do not degrade enough of the lignin to cause the cellulose fibers to separate into a fibrous decay.

Figure 6. *Brown cubical decay.*

White rot fungi decompose all cell wall components although not always uniformly (Figure 7). White rots are usually rather fibrous because lignin decomposition causes the cells and fibers to separate. Wood decayed by white rot fungi may also be yellow or yellow-brown in color.

Decays caused by these fungi are further subdivided into:

►Stringy rots

Stringy decays occur when the longitudinal fibers are slow to break down but are

Figure 7. *White pocket rot.*

easily separated, often into long strings as with decay produced by the Indian paint fungus (*Echinodontium tinctorium*) or *Armillaria ostoye* (Figure 8).

►Pocket rots

Some white rot decays produce small pockets where most of the wood has been removed, leaving a residue of light-colored cellulose. Pockets produced by some decays have this white lining while other decays produce empty pockets.

Figure 8. *White stringy rot caused by Armillaria ostoyae.*

Phellinus pini (red ring rot) produces a white pocket decay (Figure 7), while *Hirschioporus abietinus* (pitted sap rot) produces an empty or hollow pocket decay.

►Spongy rots

Spongy decays occur when the breakdown is more uniform, producing a general softening of the wood that eventually becomes spongy when squeezed. *Perenniporia subacida* (spongy root and butt rot) produces a spongy decay.

►Mottled rots

Mottled decays show white to yellow discolorations on fractured wood surfaces. These discolorations or blotches do not develop into pockets but remain evident as the wood is degraded. *Ganoderma applanatum* (artist's conk) produces a mottled decay.

►Cubical rots

These are similar to the brown cubical decay described above but are very light in color.

The wood decay process can be divided into two categories:

1. Incipient decay is the earliest stage of decay, identified by wood discoloration or staining. In the incipient stage, the fungus has invaded the wood but has not degraded it to the point where it has lost a significant amount of strength or developed the decay form typical of the fungus. It is difficult to identify the causal organism of incipient decays unless the species attacked or the pattern of discoloration provides a definite clue.

Note: The blue stain in the sapwood of pines attacked by bark beetles and in cut pine logs is not incipient decay. Blue stain does decrease the value of the log but does not affect strength properties. A condition known as wetwood is common in grand fir. Wetwood is heartwood near the

Figure 9. *Incipient and advanced decay in grand fir.*

base of the tree that is infused with water and appears water soaked or discolored (Filip et al. 1984). It is not incipient decay, although it often affects the grade of lumber manufactured from it.

2. Advanced decay is present when woody cells have been degraded and the decay has taken on its characteristic form or pattern. Wood with advanced decay has lost much of its strength.

The incipient stage always precedes the advanced stage as the decay progresses radially or longitudinally in the stem (Figure 9).

Identification

Most wood decay fungi act in slightly different manners as they break down the cell walls producing characteristic decays. Many of these decays are unique enough to provide positive identification. Others are very similar and are difficult to identify without the presence of conks or laboratory cultures of decayed wood. Many decay fungi inhabit only one or several tree species, making identification easier.

Management

Sap Rots:

Sap rots are often initiated by fungi carried into the tree on the bodies of attacking wood-boring insects. These decays will continue to progress after the tree dies. They will also continue to degrade sapwood in cut logs both in the woods and in decks at the mill.

Management considerations:

- The loss of sapwood to decay reduces the diameter of the scaling cylinder on the small end of the log (Figure 10). This can reduce merchantable volume of logs by about a third.
- The sapwood is usually decayed within two years of insect attack and one year of when the crowns turn red (usually the spring following insect attack).
- To minimize losses due to sap rots, quick harvest of trees attacked by bark beetles and wood borers is recommended; if possible, while the trees are still green.
- Mills should quickly utilize logs with evidence of insect attacks or sap rot. Storing the logs can result in further loss of merchantable volume.

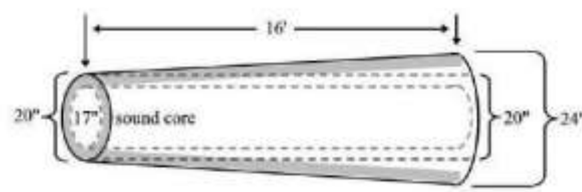


Figure 10. *Log showing scaling diameter reduction resulting from advanced sap rot. Photo: Idaho Log Scaling Manual.*

Heart Rots:

Most heart rots are thought to enter trees through wounds that leave heartwood exposed. These wounds include broken tops, scars from fire or logging, and broken and dead branches. An exception to this is the Indian paint fungus (*Echonodontium tinctorium*) that is reported to infect grand fir through small branchlet stubs before they are overgrown. These infections can remain dormant for 50 or more years before being reactivated by mechanical injuries (Filip *et al*. 1990). Gara *et al*. (1985) found the occurrence of butt rot to be related to fire-killed roots. The killed roots apparently were the entry point for heart rot fungi that then spread into the stumps and butts of the trees. While the majority of the trees with decay had visible fire scars, many infected trees did not have fire scars.

Management considerations:

- Heart rots are mainly a problem in older stands. Older trees have had more opportunity for injury and have been alive long enough for established decays to become extensive.
- Losses to decay are best controlled by cutting older defective stands and converting them to young vigorous stands.
- Since trees often require 25 or more years to develop heartwood, and decay usually progresses slowly, heart rot should not be a major problem in young vigorous stands.
- Leaving small but long suppressed advance regeneration for next rotation crop trees often results in increased losses to decay, especially with grand fir.
- Leaving trees weakened by decay for wildlife or shelter trees will result in increased wind breakage. For safety reasons, avoid leaving trees with signs of heart rot along roads and other high use areas.

Harvest considerations:

1. Minimize injury to residual trees:
   - Utilize straight skid trails to reduce the number of turn trees.
   - Use care in felling to reduce injury to leave trees.
   - Use mechanical harvesters.
   - Restrict logging in the spring and early summer when the bark is loose to minimize damage to leave trees.
   - Select burning and other slash management activities that minimize injury to the roots of the remaining trees.
2. Cut injured trees with broken tops or that are skinned during felling or skidding unless left for wildlife trees (Figure 11).

Figure 11. *Tree injured during harvest operations.*

3. When commercial and precommercial thinning thin-barked species such as hemlock, avoid heavy thinning that results in sun scalding. Sun scalding provides an entrance for stem decay fungi.

4. Sanitation – Cutting defective trees
   - Cut defective trees in high use areas such as roadside and recreation areas to reduce safety hazard.
   - Note that sanitation cuts probably won’t reduce future infections in the stand.
   - Removing defective trees provides growing space for young sound trees.

5. Merchantability standards – According to the Idaho Log Scaling Manual, the following general rules apply to scaling logs containing decay and other defects (unless written scaling specifications provide otherwise):
   - Sawlogs must be at least 1/3 sound. This means that the decayed volume of the log cannot exceed 2/3 of the gross volume of the log as determined by the small end scaling diameter of the log

segment.

- Pulp logs are log segments that are suitable for the manufacture of wood chips rather than lumber or plywood. Pulp logs must be at least 50% sound based on the entire volume of the log, not just the small end diameter scaling cylinder. In addition, bark on pulp logs must be able to be mechanically removed . This excludes logs with forks, deep splits, shattered log ends, excessive sweep or crook, bark inclusions, char and imbedded metal objects.

References

Anonymous. 2002. Idaho log scaling manual. Idaho Board of Scaling Practices 113 p.

Filip, G.M., J.W. Schwandt, and S.K. Hagle. 1990. Estimating decay in 40- to 90-year-old grand fir in the Clearwater region of northern Idaho. USDA Forest Service Pacific Northwest Research Station Research Paper PNW-RP-421. 16p.

Filip, G.M., P.E. Aho, and M.R. Wiitala. 1984. Strategies for reduction of decay in the interior Douglas-fir and grand fir forest types, p. 73-80. *In*: D.M. Baumgartner and R. Mitchell (eds.) Silvicultural Management Strategies for Pests of the Interior Douglas-fir and Grand Fir Forest Types. Symposium Proceedings Feb. 14-16, 1984. Spokane, WA. Coop. Extension and Dept. Forest and Range Management, Wash. State Univ. Pullman, WA., E.M. and E.A. Willhite. 2006. Field guide to the common diseases and insect pests of Oregon and Washington conifers. R6-NR-FID -PR-01-06. USDA Forest Service Pacific Northwest Region. Portland, OR. 327p.

Gara, R.I., W.R. Littke, J.K. Agee, D.R. Geiszler, J.D. Stewart, and C.H. Driver. 1985. Influence of fires, fungi and mountain pine beetles on development of a lodgepole pine forest in south-central Oregon. p. 153-162. *In*: D.M. Baumgartner, R. G. Krebill, J.T. Arnott, G.F. Weetman (compilers). Lodgepole Pine The Species and Its Management – symposium proceedings; May 8-10, 1984; Spokane, WA. Coop. Extension and Dept. Forest and Range Management, Wash. State Univ. Pullman, WA.

Goheen, E.M. and E.A. Willhite. 2006. Field guide to common diseases and insect pests of Oregon and Washington conifers. R6-NR-FID-PR-01-06. Portland, OR: USDA Forest Service, Pacific Northwest Region. 327 p.

Hagle, S.K., K.E. Gibson, and S. Tunnock. 2003. Field guide to diseases and insect pests of northern and central Rocky Mountain conifers. USDA Forest Service State and Private Forestry Northern Region. Missoula, MT. 196p. www.fs.fed.us/r1-r4/spf

Partridge, A.D., and D.L. Miller. 1974. Major wood decays in the Inland Northwest. Natural Resource Series No. 3. Idaho Research Foundation. Univ. of Idaho. Moscow, ID. 125p.

Useful Links

USFS Region 1 Field Guide

USFS Region 1 Management Guide

Prepared by:

Daniel L. Miller

Precision Forestry LLC

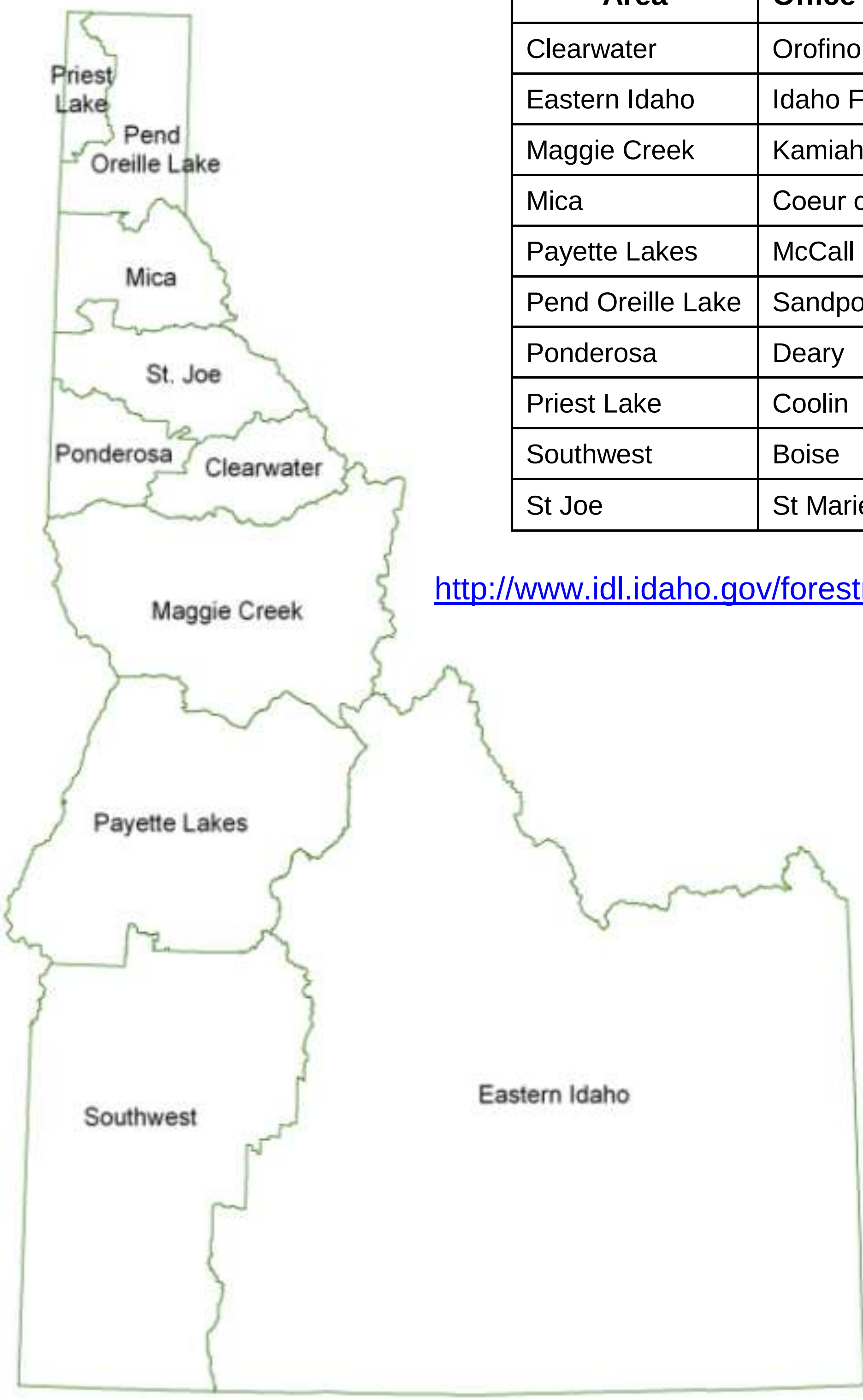
1205 Lundquist Lane

Moscow, ID 83843

(208) 882-4022

FOR MORE INFORMATION CONTACT ANY IDAHO DEPARTMENT OF LANDS PRIVATE FORESTRY SPECIALIST

Area	Office Location	Phone
Clearwater	Orofino	(208) 476-4587
Eastern Idaho	Idaho Falls	(208) 525-7167
Maggie Creek	Kamiah	(208) 935-2141
Mica	Coeur d'Alene	(208) 769-1577
Payette Lakes	McCall	(208) 634-7125
Pend Oreille Lake	Sandpoint	(208) 263-5104
Ponderosa	Deary	(208) 877-1121
Priest Lake	Coolin	(208) 443-2516
Southwest	Boise	(208) 334-3488
St Joe	St Maries	(208) 245-4551



http://www.idl.idaho.gov/forestry/forest-health/index.html