



United States Department of Agriculture
US Forest Service
Natural Resource Manager (NRM)



FSVeg Common Stand Exam User Guide Insects & Diseases – Categories 26-99

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STEM RUSTS (CATEGORY 26)

Some fungi invade stems and branches and cause localized infection in the bark and underlying woody tissues; these necrotic lesions are called cankers. The initial symptom is a localized swelling; over time, this tissue dies and contracts, leaving sunken dead areas. Cankers on the main stem may kill the tree by girdling; those on branches usually cause only flagging. Cankers are often bordered by ridges of callus tissue. Field identification of cankers is based on host species and shape of stem swelling.

Five-needle pines:

- Spindle or diamond-shaped swelling with yellow- green margins, dead bark “blistered” and cracked, and orange-yellow spores present in late spring/early summer indicate White pine blister rust.

Two- or three-needle pines:

- Slight swellings longer than wide (2:1 or 3:1), resin-soaked orange spores present in early summer indicate Comandra rust.
- Slight swelling very long and narrow (10:1 length to width); resin- soaked wood with bark missing from canker face, roughly diamond- shaped indicate Stalactiform rust.

Pronounced, globose swellings, as wide as long (1:1) indicate Western gall rust.

(26-001) WHITE PINE BLISTER RUST

Species: *Cronartium ribicola*

Host: Western white pine, eastern white pine, whitebark pine, sugar pine, limber pine, Southwestern white pine

Injury: Areas of bark may be discolored (outer edges of the discoloration yellowish-green to orange). The bark contains shallow blisters and masses of orange aeciospores. The stem and branches may contain spindle or diamond-shaped swelling accompanied by scaly lesions and black scars. There is copious resin exudation from ruptured bark in the area of infection. The girdled tops or branches will produce red "flagging" of the foliage. Saplings and seedlings usually die from infections, and larger trees can sometimes be killed. *Ribes spp.* (currants and gooseberries) is an alternate host.

Defect: Is confined to killed tops, branches, or trees or the gall area.

Figure 1: Top kill

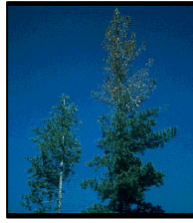


Figure 2: Branch lesions



(26-002) WESTERN GALL RUST

<u>Species:</u>	<i>Peridermium harknessii</i>
<u>Host:</u>	Ponderosa pine, Scots pine, knobcone pine, jack pine, coulter pine, Jeffery pine, Monterey pine, digger pine, lodgepole pine
<u>Range:</u>	Transcontinental
<u>Injury:</u>	It can cause growth loss and stem deformation. The galls form on infected branches or stems. It is distinguished by round or pear-shaped galls that may grow to 12 inches in diameter. Pustules of yellow or orange spores form in bark cracks on galls in spring. Galls grow each year until they eventually girdle the branch or stem. Stem infections may result in "hip cankers" (flattened swellings wider than the tree's diameter) that remain active for up to 200 years before the stem is completely girdled.
<u>Defect:</u>	Is confined to the gall area except hip cankers may distort wood 2-3 feet in both directions from each gall.

Figure 3: Branch gall



Figure 4: Hip cankers



Figure 5: Branch galls



(26-003) STALACTIFORM BLISTER RUST

Species: *Cronartium coleosporioides*

Host: Lodgepole pine, Jeffery pine, jack pine, ponderosa pine

Range: Restricted to high elevations above 5,000 feet in the western and Lake states

Injury: Cankers have resin-soaked wood. Mostly found in lower crowns in Jeffery pine. Cankers are many times longer than they are wide and covered by heavy resin flow. Branch infections cause flagging; main stem infections may cause top dieback or tree death. Rodent chewing of the bark and cambium near the canker edges is usually evident.

Description: Flagged branches have cankers with rough bark and, in late spring, pustules of yellow or orange spores. Stem cankers on young trees or small cankers on larger trees have roughened bark, heavy resin flow, and often insect boring in the killed cambium. With time, stem cankers slough the dead bark at the center. Dead, resinous sapwood is ridged in target form. Pustules of yellow or orange spores are sometimes found at the edges of stem cankers in early spring.

(26-004) COMANDRA BLISTER RUST

<u>Species:</u>	<i>Cronartium comandrae</i>
<u>Host:</u>	Lodgepole pine, jack pine, Scots pine, loblolly pine, knobcone pine, shortleaf pine, Jeffery pine, Austrian pine, Table Mountain pine, red pine, pitch pine, ponderosa pine
<u>Range:</u>	Western states, Lake states, and southern states
<u>Injury:</u>	Wood in the canker area is resin-soaked, and copious amounts of resin may flow from the canker. Other symptoms are similar to those for white pine blister rust on white pines. Spindle-shaped cankers appear on branches and main stems and flagging of infected branches is common. Top kill and tree mortality are prevalent. Porcupines and other rodents generally chew the margins of cankers.
<u>Description:</u>	Flagged branches have cankers with rough bark and, in late spring, pustules of yellow or orange spores. Stem cankers on young trees or small cankers on larger trees have roughened bark, heavy resin flow, and often insect boring in the killed cambium. With time, stem cankers slough the dead bark at the center. Dead, resinous sapwood is ridged in target form. Pustules of yellow or orange spores are sometimes found at the edges of stem cankers in early spring.
<u>Defect:</u>	Is confined to the canker area.

Figure 6: Canker on branch and main stem of lodgepole pine



Figure 7: Canker on branch and main stem of lodgepole pine



Figure 8: Areas of management concern

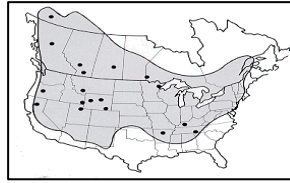


Figure 9: Dead tops



(26-005) PINYON BLISTER RUST

Species: *Cronartium occidentale*

Host: Pinyon pine, singleleaf pine

Injury: *Ribes spp.* (currants and gooseberries) is an alternate host. Multiple branch and bole swellings and cankers are common and occasionally kill the tree.

Description: White spore sacs with bright orange spores.

(26-006) EASTERN GALL RUST

Species: *Cronartium quercuum*

Host: Virginia pine, sand pine, Scots pine, Jeffery pine, pond pine, Jack pine, Austrian pine, spruce pine, pitch pine, ponderosa pine, loblolly pine, Table Mountain pine, shortleaf pine

Range: Eastern states

- Injury: Oak is the alternate host. Round galls form on the main stem or branches. Portions of the tree beyond the galls normally die. In the spring, the galls on pines turn orange. In the summer, orange leaf spots develop on the oak host. It can kill small trees, and losses can be severe in nurseries, Christmas tree plantations, and young stands. In older stands, trees with trunk infections may develop decay and can be easily broken off by wind.
- Description: The fungus produces orange spores on the surface of the round pine galls. Orange spores are produced on the lower surface of the oak leaves. Later, hair-like structures are produced on the oak leaves.

(26-007) GALL RUST OF JACK PINE

- Species: *Cronartium quercuum f. sp. banksugnae*
- Host: Jack pine
- Injury: The fungus causes the development of globose galls on the stems. Hyphae occur mostly in rays; abundantly in the bark and sparingly in the wood.

(26-008) GALL RUST OF SHORTLEAF PINE

- Species: *Cronartium quercuum f. sp. Echinatae*
- Host: Shortleaf pine
- Injury: The fungus causes the development of globose galls on the stems. Hyphae occur mostly in rays; abundantly in the bark and sparingly in the wood.

(26-009) FUSIFORM RUST

- Species: *Cronartium quercuum f. sp. fusiforme*
- Host: Slash pine, loblolly, pitch pine, pond pine, black oak, white oak, willow oak

Injury:

The disease has five spore forms, which are produced in succession. It takes 2 years or more to complete the life cycle. From late February to early April, the fusiform galls on infected pines produce enormous numbers of orange aeciospores. These are carried by the wind and air currents to oak leaves. When they are deposited on young oak leaves, the spores germinate and cause localized infections. In 7 to 10 days, the rust, fungus produces a small pustule that bears orange urediospores on the lower surface of the leaf. These urediospores cause infections on the same leaf or on other oak leaves and are often referred to as the repeating stage of the fungus. After a week, telia, appear on the lower surface of the leaf but not necessarily associated with the uredial pustules. Depending on the severity of infection, each leaf may have a few to several hundred telia. Each telium is made up of several hundred teliospores, which may remain viable until early June.

When conditions are favorable (temperatures between 60° and 80° F and relative humidity between 97 and 100 percent for 4 or more hours) the teliospores germinate; each produces three to four basidiospores (sporidia). The basidiospores are carried by air currents to susceptible pine hosts. Infection occurs on cotyledons, on needles, or on succulent bark tissues. Sporidia are very sensitive to adverse conditions and quickly lose their germinative capacity. Once the host is successfully infected, the developing fungus grows through the host tissue into the branch or stem. In 4 to 6 months, a gall or swelling begins to form. If the disease does not kill the pine host during the first few months after infection, drops of orange fluid containing pycniospores appear on the gall surface. Occasionally, pycniospores occur during the year of infection; more often, they appear from October to January of the following year. Aeciospores are produced on the gall during the next spring, thus completing the life cycle.

In oaks, only the leaves are affected, and the fungus is usually inactivated or killed when temperatures exceed 85° F for several days. The oaks are free of the disease in winter, when they cast their leaves. In pines, however, the fungus persists until the infected tissues are killed; aeciospores can be produced for many years in succession. Old galls may develop into open-faced cankers when the pine tissues are killed at the margin of the gall. These cankers are often invaded by insects and wood-rotting fungi, which further reduce the tree's value and make it susceptible to wind breakage.

Figure 10: Schematic diagram of the life cycle of fusiform rust

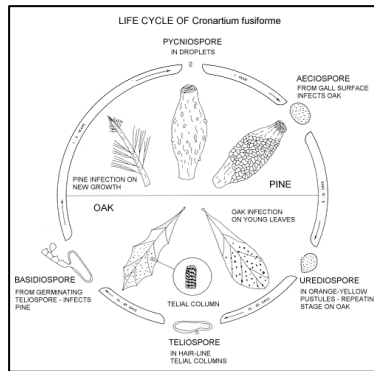


Figure 11: Pine plantation with pole infection



Figure 12: Urediospores on oak



Figure 13: Brown hairline telia on underside of oak leaves

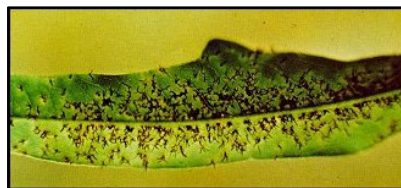


Figure 14: Fusiform rust



(26-010) GALL RUST OF VIRGINIA PINE

- Species: *Cronartium quercuum f. sp virginianae*
- Host: Virginia pine
- Injury: The fungus causes the development of globose galls on the stems. Galls on the trunk, partially grown over, result in lesions that resemble "hip canker" caused by the western gall rust. Hyphae occur mostly in rays; abundantly in the bark and sparingly in the wood.

(26-012) LIMB RUST

- Species: *Peridermium filamentosum*
- Host: Apache pine, ponderosa pine, Jeffery pine
- Injury: Dead limbs are found in mid-crown or upper crown of mature trees. Dead limbs with recently killed red needles attached. Bright orange spores on portions of living bark in affected area. Ragged remains of spore sacs are found on twigs.

(26-013) SOUTHERN CONE RUST

- Species: *Cronartium strobilinum*
- Host: Slash pine, longleaf pine
- Injury: Infected first year conelets enlarge and swell 4 to 4 times their normal size. The swollen conelet scales are reddish in color. Later, the conelet appears orange in color. Infection on the oak host produces orange leaf spots and hair like telia, which can cause cupping and curling of the leaf.

Description: The fungus requires two hosts. Orange spores are produced in blisters in the first year conelets. These blisters burst, causing the cones to appear yellow-orange. Orange leaf spots are produced on the oak. Later, hairs like structures are produced on the oak leaf.

BROOM RUSTS (CATEGORY 27)

(27-001) SPRUCE BROOM RUST

Species: *Chrysomyxa arctostaphyli*

Host: Englemann spruce, Norway spruce, white spruce, black spruce, blue spruce, red spruce, Sitka spruce

Injury: The alternate host is kinnikinnik. Broom rusts produce typically upright, compact, yellow witches' brooms with dense growth of many small and shortened branches. The diseased needles within the broom are generally short and thickened. Needles drop from brooms in autumn; brooms appear dead in winter. New needles are yellowish-green in color. Brooms are most conspicuous in mid-summer due to color of the needles coupled with the presence of yellow-orange spore pustules on infected needles. Broom rust witches' brooms are often mistakenly identified as dwarf mistletoe witches' brooms. Presence of dwarf mistletoe plants should be used to separate the two causal agents. Spore pustules are not associated with dwarf mistletoe infections. Dwarf mistletoe infection does not usually result in conspicuously shortened and thickened needles.

(27-002) INCENSE CEDAR BROOM RUST

Species: *Gymnosporangium libocedri*

Host: Incense cedar

Injury: It infects trees of all ages. It causes witches brooms and infrequently kills smaller branches. Badly infected trees may be seriously injured, but rarely killed. Infection in the main stem may result in burls. In early spring, infected small branches appear slightly discolored. On the underside of the leaves a number of small brown to brick colored tufts or cushions appear.

(27-003) JUNIPER BROOM RUST

Species: *Gymnosporangium nidus-avis*

Host: Eastern redcedar, Rocky Mountain juniper

Injury: This causes the typical “witches broom” formations. In addition, the leaves may take on the awl-shaped juvenile form. This rust also causes long spindle shaped swellings on the trunks and branches of large trees, which may result in death.

(27-004) FIR BROOM RUST

Species: *Melampsorella caryophyllacearum*

Host: True fir

Injury: The alternate host is Chickweed. Broom rusts produce typically upright, compact, yellow witches’ brooms with dense growth of many small and shortened branches. The diseased needles within the broom are generally short and thickened. Needles drop from brooms in autumn; brooms appear dead in winter. New needles are yellowish-green in color. Brooms are most conspicuous in mid-summer due to color of the needles coupled with the presence of yellow-orange spore pustules on infected needles. Broom rust witches’ brooms are often mistakenly identified as dwarf mistletoe witches’ brooms. Presence of dwarf mistletoe plants should be used to separate the two causal agents. Spore pustules are not associated with dwarf mistletoe infections. Dwarf mistletoe infection does not usually result in conspicuously shortened and thickened needles.

FIRE (CATEGORY 30)

(30-000) FIRE

Description: Damage usually occurs as basal scars. The charred or blackened wood will remain for many years and serves as positive identification. While fire scars serve as an avenue for infection, often in tree species such as ponderosa pine, little more than the first 4 feet may be cull. Fire damage that has killed more than half the cambium of the bole circumference has seriously affected the tree's chance of survival. Fire damage from ground fires that reach into the upper crown should also be considered severe. Fire damage that affects less than ½ the cambium or ground fires that have damaged foliage on the lower crown, is usually not serious, depending on the tree.

WILD ANIMALS (CATEGORY 41)

(41-001) BEARS

- Injury: Bark is removed from the lower 1/3 to 1/2 of the stem, and bark strips are usually present near the base of the tree. Vertical striations are often visible on the cambium.
- Defect: No volume loss unless the affected area fails to heal, in which case the damage will be assessed as a dry face.

Figure 15: Tree wounded by a brown bear; note the teeth marks in the exposed wood



(41-002) BEAVER

- Injury: Seedlings and saplings are severed near the ground or saplings are stripped of lateral branches. Tooth marks visible, burrows with loose soil in area. Wide tooth marks on the remaining stumps. Damage occurs near creeks or ponds, where beaver dams are usually evident.
- Defect: Is limited to the chewed area on the tree.

(41-003) BIG GAME

- Injury: Deer and elk will clip terminal and lateral shoots within their reach. Often a distinct "browse line" is visible. Antler rubbing of young stems strips the bark, often several feet in length. Droppings and tracks may be present near damaged trees. Trample and uproot newly planted seedlings.
- Defect: No volume loss unless the affected area fails to heal, in which case the damage will be assessed as a dry face.

(41-004) MICE OR VOLES

Injury: Mice and voles sometimes girdle the stems of small trees, and may cause heavy damage in areas with thick grass cover. Signs of mouse activity include runways that are about 2 inches wide and cleared of vegetation, piles of droppings, small caches of clipped grass, and tooth marks in the cambium or wood.

(41-005) POCKET GOPHERS

Injury: These rodents feed on seedling roots, weakening or killing the trees. Flattened, fan-shaped mounds of soil with obvious holes can be used to identify pocket gopher activity. (Moles (insect eaters that do not usually damage trees) create “volcano-shaped” mounds without obvious holes. Do not associate these with pocket gopher presence.)

(41-006) PORCUPINES

Injury: Porcupines often cause damage in young stands of fast-growing timber where they seem to favor the very best trees. They may climb 20-30 feet to girdle the stem in the upper portion of the crown. Large bark chips may be found at the base of the tree. This damage may kill the top, thus deforming the tree and reducing the growth rate.

Description: Girdled tops will rot quickly. They must be culled.

Figure 16: Bark removal from porcupine feeding



(41-007) RABBITS OR HARES

Injury: Stems and lower branches may be stripped or girdled by rabbits and hares. Damage occurs only as high on the stem as these animals can reach when standing on their hind legs. Small branches may be clipped off with clean, slanted cuts. Droppings and tracks may be visible near damaged trees.

(41-008) SAPSUCKER

Injury: Sapsuckers, particularly the yellow-bellied sapsucker in the East, often injure or kill trees. These birds favor yellow birch, paper birch, hemlock, and aspen, but also damage other species. Sapsuckers drill small holes in the trees and drink the sap or feed it to their young. They nest in hollow trees (usually aspen) near their “orchards” and return repeatedly to favorite trees. When heavily drilled, a section of bark dies, and decay fungi can enter the tree. Sometimes the tree, or top of the tree, is completely girdled and killed. Sapsucker holes cause defects in lumber. The injuries also lead to separation of the wood layers within the tree, called “shake.”

Defect: The damage is showy, but does not cause cull.

Figure 17: Sapsucker damage



(41-009) SQUIRRELS

Injury: Needle fascicles from cone-bearing portions of a tree are clipped and left scattered on the ground within the drip line of the tree's crown. Can clip or girdle small seedlings. They also chew on bark around lesion areas.

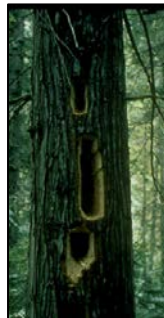
Figure 18: Girdling of paper birch caused by feeding of red squirrels



(41-010) WOODPECKERS

<u>Injury:</u>	Produce large (approximately 203x408 inch) rectangular holes, several inches deep in certain trees.
<u>Defect:</u>	The holes cause local loss to the depth of the holes but, more importantly; their presence indicates insect borers and heartwood loss in affected trees. Generally, heartwood 4 feet in both directions from the woodpecker's hole is defective.

Figure 19: Woodpecker damage



DOMESTIC ANIMALS (CATEGORY 42)

(42-000) LIVESTOCK

<u>Injury:</u>	Trample smaller trees and seedlings. Livestock can rub off the bark when they are scratching. Damage from grazing by domestic animals is usually confined to trees of seedling-sapling size, and is serious when the trees have become so decimated or deformed it is unlikely they will develop into marketable products.
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ABIOTIC DAMAGE (CATEGORY 50)

INTRODUCTION

Local knowledge of weather conditions, particularly recent events such as windstorms, spring frosts, temperature inversions, etc., is useful for determining if observed injuries to trees are weather related.

(50-001) AIR POLLUTION

Injury: Air pollution injury occurs when toxic gases are emitted from smelters, reduction plants, or coal-burning industries and power plants. The foliage usually absorbs the gases for a prolonged period before the injury becomes visible. Symptoms and severity of damage vary between tree species, between concentration and type of gas, duration of exposure, and distance from the source. Discoloration of conifer needles starts at the tips, while broad-leaved foliage is affected first in the tissues between the veins, giving the leaf a mottled appearance. Foliage, buds, branches, and entire trees may be killed; damage sometimes occurs over an extensive area.

Figure 20: Damage to western spruce foliage by sulfur dioxide emissions



(50-002) CHEMICAL

Injury: Drift and misapplication of herbicides can often damage non-target trees. All tree species can be damaged. Identification is done primarily through symptom expression of the tree and determination of the method and rate of nearby chemical applications. Some chemicals cause growth abnormalities such as cupping or twisting of foliage while others cause foliage yellowing or browning, defoliation, or death.

(50-003) DROUGHT

Injury: All ages of needles can be affected. Older needles are brown or red. The new flush appears wilted, turning from light tan to yellow to brown. Trees undergoing moisture stress may lose needles, grow slowly, wilt, and eventually die. These weakened trees are often attacked by other agents.

(50-004) FLOODING/HIGH WATER

Injury: There is prolonged soil saturation with water, commonly in areas with a high water table. Entire trees may suddenly die and the crowns turn brown-red. Roots are sound but have enlarged and swollen lenticels. No fungi, insects, or other symptoms are present.

Defect: A tree may be killed, but is not otherwise defective unless other indicators are present.

Figure 21: Enlarged, swollen roots from high water



Figure 22: Enlarged, swollen roots from high water



(50-005) FROST

Injury: Frost damage to foliage usually occurs when new foliage or shoots are exposed to extremely cold temperatures. The foliage appears blighted, and may wilt or turn red; generally, only the needle tips are tinged. Frost damage is known mostly by its occurrence in a localized area at a given time. Frost damage to foliage usually occurs when a warm spell is followed by a cold snap. Generally, only the needle tips are tinged.

Damage: Cull 2 inches to both sides of the frost crack to the tree's center. In a tree with an old, lipped crack all the heartwood will be decayed and water soaked. In grand fir with bleeding around the crack, ring shake will have ruined the heartwood.

Figure 23: Frost cracks



Figure 24: Frost injury of spruce



(50-006) HAIL

Injury:

Hailstorms can cause several levels and types of damage, from wounding of the bark and cambium to death of young trees and sprouts. The degree of damage depends on severity of the storm, size of the hailstones, and time of year. Conifer shoot breakage or laceration of hardwood leaves may sharply check tree growth. Severe bruising or breaking of the bark and cambium may create entry points for wood decay fungi and insects. Younger stems with tender bark or trees with developing foliage in early spring are most seriously damaged. Trees with flexible stems and tender bark, such as eastern white pine, are especially susceptible to hail damage.

(50-008) LIGHTNING

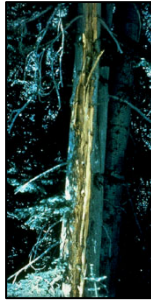
Injury:

Lightning can sometimes kill the tree as well as shatter the wood, create an open wound through which infection can enter, retard growth, etc. Lightning scars tend to spiral around the tree. Trees that survive lightning strikes are often attacked by bark beetles, decay fungi, or other agents.

Defect:

A strip 3 inches to each side of the injury and 8 inches deep will be cull.

Figure 25: Lightning scar



(50-010) RADIATION

Injury: Rapid increases in stem temperature may kill plant tissue. When this damage occurs, it is often found on the south or west sides of tree boles.

(50-011) SNOW/ICE

Injury: Snow damage occurs as breakage due to heavy loads of snow that break off limbs, or bend over the trees in the case of seedlings and saplings. Such bent over trees seldom recover, and the damage is serious. Bole cracks occur usually during extremely low temperatures, especially when there is a sudden drop in temperature. The inside of the tree is warmer than the outside. The outside shrinks faster causing a split to occur. These cracks provide avenues for infection and damage the wood, but they often close and heal over, and the tree may remain sound. Bole cracks tend to run up and down on the same side of the tree.

(50-013) WIND/TORNADO

Injury: Wind damage usually occurs as blow downs, where trees are uprooted and blown over. This may occur in residual stands after logging or following a windstorm. Tops may be broken out of trees. A rare phenomenon is jet stream touchdown, which sometimes hits areas of 4-20 acres, creating a real havoc in which trees are broken up as well as blown down.

Figure 26: Windthrow



(50-014) WINTER INJURY

Injury:

Winter winds may lead to severe drought for exposed trees that are not able to replace water lost through transpiration. Also known as parch blight, this condition causes foliage to turn brown in late winter or early spring and may lead to shoot die back or tree death. Damage is pronounced on the windward side of trees. In mountainous country, injury may be confined to an elevation zone corresponding to the pathway of drying winds or to the transition zone between warm and cold air in a temperature inversion; hence the name “red belt.”

Figure 27: Winter drying



HUMAN ACTIVITIES (CATEGORY 70)

(70-007) LOGGING DAMAGE

Injury:

Logging damage appears as trunk and basal scars or wounds caused by falling trees, scraping along the trunk or logs being skidded against the base of the tree. Leave trees may suffer certain damage same as logging damage from removal of excess trees during thinning.

Defect:

Is limited to the wound area unless borers or decay are also present.

(70-014) ROAD SALT

Injury: Most damage is to the foliage, but eventually the roots may be killed. Damage stems primarily from salt applied to streets and highways during snow and ice storms. Calcium-based salts are less damaging than sodium salts. Trace elements within the salt, such as bromine, can reduce the degree of tree resistance to other pests. Salt injury lowers the cold-hardiness of several species. Species subject to winter injury are generally more susceptible to salt injury than cold-hardy species. Trees planted north of their natural ranges are more likely to be injured. Some trees resistant to salt injury are black locust, honey locust, ponderosa pine, green ash, mulberry, Japanese black pine, and eastern red-cedar. Trees susceptible are white pine, sugar maple, red maple, larch, cottonwood, aspen, basswood, black walnut, red pine, hemlock, balsam fir, northern white cedar, beech, and white spruce.

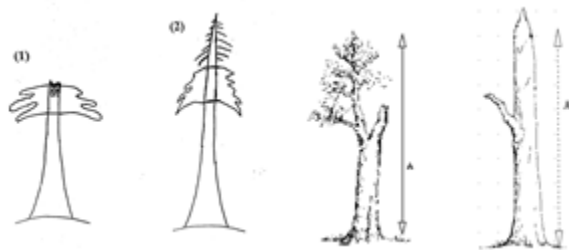
PHYSICAL EFFECTS (CATEGORY 99)

(99-001) BROKEN TOP / (99-002) DEAD TOP

Defect: Measure the height to the break and add an additional 2 feet for shatter. If a dead top includes merchantable material, include the entire tree down to the first set of green limbs. The dead portion will probably shatter upon hitting the ground and be unmerchantable.

Defect Example: The height to the break is 34 feet, the top of the second log. The merchantable height was 47 feet. The entire third log is gone and counted as 22% defect. An additional 2-foot loss for shatter is accounted for in the second log. Each foot in the second log has 2.1% of the volume, hence $2 \times 2.1\% = 4.2\%$ defect. The total deduction is 26%.

Figure 28: Broken top/dead top



(99-004) FORKED TOP / (99-005) FORKED BELOW MERCH TOP

Injury:

1) On “simple” forked trees with one bark seam less than 3 feet long, with straight logs above the fork, take a 2-foot length cut.

Example: The merchantable height is 65 feet and the fork is located at 47 feet. There is one bark seam 2 feet long and straight logs above the fork. This is a 4-log tree and the fork is located in the third log. Deduct 2 feet, $2' \times 1.3\% = 3\%$ deduction.

2) For “complex” forks with multiple bark seams or one seam longer than 3 foot, plus any other related defects in the logs above the fork such as spike tops, and/or crook and sweep, make a 4 foot length cut. All these defects are grouped into one deduction.

Example: The merchantable height is 76 feet and a complex fork is located at 58 feet. The spike in the center is rotten but without additional visual indicators we can only estimate the rot extends down 2 feet. The right crook just above the fork looks like it affects $\frac{1}{2}$ of 4 feet. The left crook affects $\frac{1}{2}$ of 6 feet. All of these defects are grouped into one 4-foot length cut. This is a 5-log tree and the fork is in the fourth log, make a 4 foot length cut. $4' \times .9\% = 4\%$ deduction.

CAUTION: If a complex fork occurs close to the merchantable height and straight 8 foot logs (free of defect) do not exist, ignore the 4-foot rule and CULL the entire length above the fork.

3) For defects occurring above any fork, not related or caused by the fork, follow the standard deduction procedures. Reduce the defect percentage by the number of merchantable stems showing at the defect height (box). If 2 merchantable stems show in the box, then the defect percentage is divided by 2.

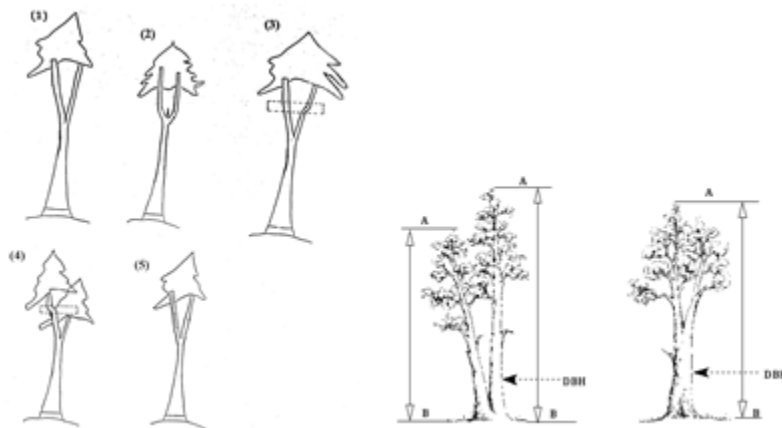
Example: This is a 4-log tree with a simple fork in the 2nd log. Besides a 2-foot bark seam, the right side log of the fork has a crook affecting $\frac{1}{4}$ of 4 feet; the crook is in the third log. At the measured height of the defect, there are two merchantable stems visible. For the fork, 2 foot length cut, $2' \times 1.8\% = 3.6\%$. This is a 4-log tree and the crook is located in the third log. $\frac{1}{4}$ of 4' = $1' \times 1.3\% = 1.3\%$, divide $1/3\%$ by 2 (number of stems in box) = $.7\%$, $3.6\% + .7\% = 4\%$ deduction.

- 4) Reduce the defect percentage by the number of merchantable stems showing at the defect height (box).

Example: This is a 4-log tree with a simple fork in the 3rd log. This tree has a crook on the tallest side in the fourth log. The defect affects $\frac{1}{2}$ of 4 feet for a 2-foot length cut. The percent of volume for one foot is 1.3%. At the measured height of the defect, there is only one merchantable stem still visible. The short log's top DIB is measured below the box. The defect percentage for this crook is not reduced. Use a 2-foot length cut for the simple fork in the 3rd log. The simple fork = $2' \times 1.3\% = 2.6\%$, 4th log crook = $2' \times .9\% = 1.8\%$, $2.6\% + 1.8\% = 4\%$ deduction.

5) This 5-log tree has a lightning strike in the top of one fork. The defect affects $\frac{1}{4}$ of the entire length of the scar. The tree has a simple fork at 52 feet. There are two straight stems above the fork and both are still visible at the same height as the lightning strike damage. The lightning strike starts at 58 and ends at 77 feet. Add 2 feet onto the lower end of the visible scar. The upper end of the scar is at 6"; do not add on the additional 2 feet. The top of fourth log is 67 feet. Ten feet of the 5th log and 10 feet of the 4th log are affected by the lightning scar. Fifth log $\frac{1}{4}$ of $12' = 3' \times .6\% = 1.8\%$ divided by 2 visible stems = $.9\%$, 4th log $\frac{1}{4}$ of $12' = 3' \times .9\% = 2.7\%$ divided by 2 = $1.35 = 1.4\%$, simple fork at $52' = 2' \times .9\% = 1.8\%$. $1.4\% + .9\% + 1.8\% = 4\%$ deduction.

Figure 29: Winter drying



(99-006) CROOK OR SWEEP

Injury: Affected stems arc or curve rather than grow straight.

Defect: Reduce estimated log lengths to produce as many useable sections as possible. When the crook or sweep is severe enough that no part of a straight log will be available, cull the crooked section.

A crook is an abrupt deviation from a straight line. A sweep is a gradual curvature of the bole. To determine if a crook is bad enough to warrant a deduction, visualize cutting through the center of the crook, and determine if either log has any evidence of the crook on their respective cut ends. If not, there is no deduction. Some crooks affect more than one log.

1) With a severe crook the bole bends, first one way then quickly bends back straight in a foot or two. The deduction will include all of this section. To determine in which log the crook is located, measure to the bottom of the crook where it first starts to bend away from a straight line. After determining what log is affected, measure to the top of the crook, where the stem straightens out. This will be the length affected.

Example: The merchantable height is 44 feet. The bottom of the crook is 30 feet; the top of the crook is 33 feet. The crook is in the second log. $3' \times 2.1\% = 6.3\% = 6\%$ deduction.

2) Most crooks are minor, affecting only 1-6 feet. Measure the height where the crook starts first, and then measure the height where the tree straightens out. This will determine which log(s) are affected and the length of the crook. To estimate the deduction, use the edge of your tatum board, or anything with a straight edge. Sight past the straight edge and line up with the side of the tree's bole. You should see the straight edge dissecting the tree, hiding part of it. The amount hidden determines the loss. If the straight edge dissects through the middle of the log, this is a $\frac{1}{4}$ loss. If it dissects the tree to the other side, this is $\frac{1}{2}$ loss. Four basic fractions are used, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{1}{8}$.

Example: The merchantable height is 71 feet. The bottom of the crook is 29 feet and the top is 33 feet. The crook affects $\frac{1}{4}$ of the second log. $\frac{1}{4}$ of 4' = 1', $1' \times 1.8\% = 1.8\%$ or 2% deduction.

Example: The merchantable height is 58 feet. The bottom of the crook is 44 feet and the top is 50 feet. The crook affects $\frac{1}{4}$ the 3rd log. $\frac{1}{4}$ of 6' = 1.5', round to two, 2' $\times 1.4\% = 2.8\%$ or 3% deduction.

3) A common occurrence is two severe bends, or crooks, with less than 8 foot of straight material between them. The total deduction will include the entire portion. This deduction may include material from more than one log.

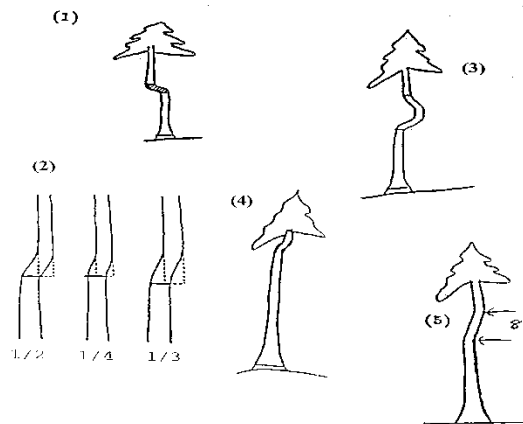
Example: The merchantable height is 71 feet. The bottom of first crook is 38 feet and the top of second crook is 46 feet. The entire length between the two crooks is affected. There is not a straight log between crooks. The crooks are in the third log. $8' \times 1.3\% = 10\%$ deduction.

4) Sometimes a crook is located in the upper log of the tree and there may not be any recoverable 8-foot material between the crook and the merchantable top, the whole section is deducted. This also occurs in the bottom logs but not as frequently.

Example 1: The merchantable height is 77 feet. The bottom of the crook is 71 feet. There are no 8-foot straight logs above the crook. Cull 6 feet of the fifth log. $6' \times .6\% = 4\%$ deduction.

Example 2: The merchantable height is 59 feet. The bottom of the crook is 1 foot and the top is 5 feet. The crook affects $\frac{1}{2}$ of the first log. $\frac{1}{2}$ of $4' = 2'$, $2' \times 2.3\% = 5\%$ deduction.

Figure 30: Crook and sweep



SWEEP

Injury:

Sweep is a gradual curvature of the stem. When sweep is minor, varying log lengths may eliminate loss. To determine which log is affected, measure the height of the apex or middle of the sweep. Trees with severe sweep may require this for several sections up the tree. Always try to line up a straight edge with the longest straight portion of the log. This will limit the lengths affected.

Example 1:

This diagram shows sweep that did not have enough defects to warrant a deduction. By varying the log lengths, the sweep is eliminated.

Example 2:

This is a 4-log tree with sweep primarily through the second log. The height at the apex is 23 feet or 6 feet above the top of the first log. Remember, this is a sweep deduction, and there is no way to vary the log lengths to eliminate the defect. Use a straight edge to help determine the loss. The dotted line on the right side projects a straight line through the log and comes out on the opposite side. This is $\frac{1}{2}$ loss of 6 foot of the second log. $\frac{1}{2}$ of 6' = 3' x 1.8% = 5% deduction.

Figure 31: Rust pustules of *Melampsora* on the underside of a leaf

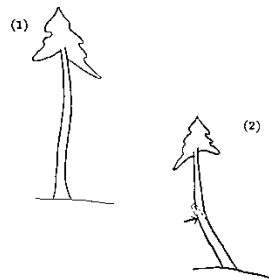


Figure 32: Crook and sweep



(99-007) CHECKS, BOLE CRACKS

Injury:

Extend the defect an additional two feet above the last visible indicator. Frost cracks are found primarily on white fir and spruce. For frost cracks that are closed, with no moisture or sticky pitch, an 1/4 pie cut for the length affected plus the additional 2 feet should be a sufficient deduction. If the frost crack is wide, is weeping moisture and/or pitch, or you can see evidence of rot, double the fraction. If you find more than one frost-crack, cull the entire section of the tree to 2 feet above the last visible indicator. On white fir, be especially observant for conks located on the underside of limbs directly above the crack.

For lightning scars, add 2 feet to BOTH ends of the scar unless the upper end of the scar extends past the merchantable top.

Example 1:

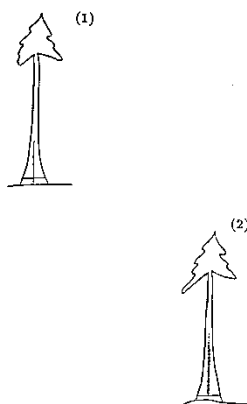
A four log white fir has a frost crack, which is relatively straight and extends for 14 feet in the butt log. The frost crack appears to be tight and is not weeping pitch or moisture. A 1/4 pie cut should account for the defect. Convert it to a length cut. $14' + 2' = 16'$ crack, $\frac{1}{4}$ of $16' = 4' \times 2.3\% = 9\%$ deduction.

Example 2:

A four log white fir has a frost crack that extends 19 VISIBLE feet. It has a substantial amount of sap running down the bark. There are no other defects. Because of the sap and the obvious age of the crack, a 1/2 pie cut is a good estimate. Adding an additional 2 feet to the 19 visible feet gives a total of 21 feet affected. Top of the first log is 17'.

$\frac{1}{2}$ of the first log = 18.5% or $8' \times 2.3\% = 18.4\%$, $\frac{1}{2}$ of 4ft of the 2nd log = $2' \times 1.8\% = 3.6\%$, and $3.6\% + 18.5\% = 22\%$ defect.

Figure 33: Checks, bole cracks



(99-012) POOR GROWTH

Injury: Trees that exhibit relatively low vigor and/or slow growth for the site conditions. Large trees will exhibit signs of decline, such as fading or sparse crowns, not readily attributable to other pathogens. Small trees will exhibit short height growths between branch whorls and short needles.

Figure 34: Large trees – foliage sparse or fading, general decline

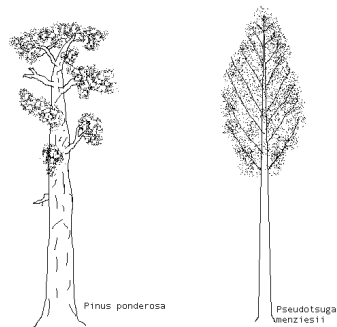
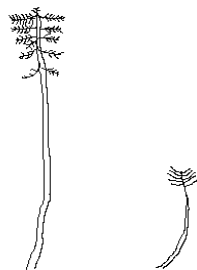


Figure 35: Poor growth seedlings



(99-013) TOTAL BOARD FOOT VOLUME LOSS (WHOLE TREE) / (99-014) TOTAL CUBIT FOOT VOLUME LOSS (WHOLE TREE)

Injury: Seen defect is that portion of the tree that is defective or not merchantable, and has enough indicators to determine the extent of the defect. All deductions will be made as a percentage of the tree, in whole numbers.

Observe what caused breakage, crack depth along the sides of butt logs compared to middle and top logs, and cat faces caused by fire scars. Observe old and new damage.

RULES

- 1) Cull includes any part of the tree, above the stump and below the specified top D.I.B., which is not merchantable because of defect.
- 2) Deductions are made by log and added together for the trees deduction. An example would be, log 1 has 12% deduction, and log 2 has 6% deduction. When added together, it is an 18% deduction for the tree.
- 3) Defects occurring in the stump, with no visible indicators occurring in bottom of the first log, are not considered for deductions.
- 4) External Indicators of Defects include: fire scars, cat faces, conks, rotten knots, cankers, crook, sweep, frost cracks, lightning scars, weeping burls, missing tops, shake, spangle
- 5) Estimate, and record, cull or missing logs as a percentage of the total tree.

SEEN DEFECT PROCEDURES

1. Determine the merchantable height
2. Determine the number of logs
3. Determine which log the defect is in
4. Determine the length affected by the defect
5. Determine the fraction of this length affected

Figure 36: Visible defect guide

Visible Defect Guide--6 inch top diameter											5/97
Merch. Height	Num of Logs	Log Tops - 16.5 + 1ft stump									
		1	2	3	4	5	6	7	8	9	10
1-25	1	100/6.3 >									
26-42	2	63/3.9	37/2.3 >								
43-58	3	45/2.8	33/2.1	22/1.4 >							
59-75	4	37/2.3	28/1.8	21/1.3	14/.9 >						
76-91	5	32/2.0	25/1.6	19/1.2	15/.9	9/.6 >					
92-108	6	27/1.7	22/1.4	19/1.2	14/.9	11/.7	7/.4 >				
109-124	7	24/1.5	21/1.3	19/1.2	15/.9	11/.7	5/.3	3/.2 >			
125-141	8	22/1.4	19/1.2	17/1.1	15/.9	11/.7	8/.5	5/.3	3/.2 >		
142-157	9	20/1.3	16/1.0	14/.9	13/.8	12/.8	10/.6	7/.4	5/.3	3/.2 >	
158-174	10	19/1.2	16/1.0	14/.9	13/.8	12/.8	10/.6	7/.4	5/.3	3/.2	2/.1

FIRE SCARS/CAT FACES

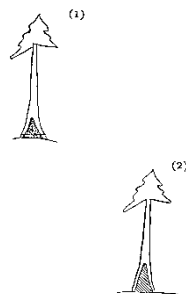
Injury:

With some defects, a deduction is not necessary because very little wood fiber is affected. Some injuries look bad but upon closer inspection, very little damage has occurred, such as a lightning strike that only peels the bark or a cat face that is in the stump only. Species is a critical element on defects that cause a fiber loss. If the visible wood is gray with long continuous cracks and wormholes, this usually indicates that the scar occurred some time ago and has penetrated the bole of the tree. Bird holes, ants, and wood dust at the base of the tree, are also good indicators that rot may be present. Older scars may have the bark curling around with the visible wood deep inside. If any of these conditions exist, extend the defect an additional two feet above the last visible indicators. For a lightning defect, add an additional 2 feet above and below the visible indicators.

The most common method is to make a wedge shaped, or "pie cut," estimate of the portion of the tree affected for the length of the defect. A common pie cut fractions is $1/4$, $1/2$, $1/3$, and $2/3$.

Example: A white fir tree, with a merchantable height of 41 feet, has a four-foot fire scar. Because the species is white fir, which rots easily, the entire 4-foot section, plus an additional 2 feet above the last visual indicator, is cull. The deduction is $6' \times 3.9 = 23\%$. If the tree was a hardier species, such as pine, the defect may only include $\frac{1}{2}$ of the six feet. The deduction is $3' \times 3.9 = 11.7$ or 12%.

Figure 37: Fire scars/cat faces



CONKS

Injury:

This guide was used to calculate the defect totals (the distance above and below the last visible conk) for the following:

Fomes pini	4 feet above – 8 feet below	DF, SP
Indian paint	8 feet above – 8 feet below	TF, SP, Aspen
Velvet top/cow dung	2 feet above scar (if there is no scar, use butt swell and if no butt swell, use 4 feet)	
Canker	2-4 feet cut at canker	Aspen, TF

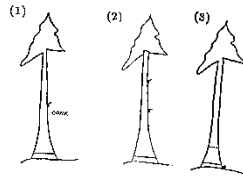
Conks are the fruiting bodies of an interior fungus. Defect percentages may be large and affect major portions of the tree. The entire tree may be cull. If the tree contains one merchantable, sound log with 1/3 or more volume, the tree is not cull.

Example 1: A white fir has a merchantable height of 80 feet. It has an Indian Paint conk at 52 feet. 52 feet is at the bottom of the fourth log on a 5-log tree. 50 feet is the top of the third log. The 2 feet (from 50 to 52) plus the 8 feet above 52 equals a 10-foot deduction from just the fourth log. Deduction would include 6 foot from the third log. Third log = $6 \times 1.2 = 7.2\%$, fourth log = $10 \times .9 = 9.0\%$; for a 16% deduction.

Example 2: A white fir has a merchantable height of 90 feet. The first Indian Paint conk is at 20 feet; the second is at 38 feet. This is a 5-log tree. From the first conk at 20 feet, subtract 8 feet. There is still 12 feet of merchantable material left in the first log. From the top conk at 38 feet, add 8 feet for 46 feet. Everything from 12 feet to 46 feet is cull; this is 4 feet short of the top of the third log. First log = $5' \times 2.0\% = 10.0$, second log = cull log 25.0 (total volume of second log) third log - $12' \times 1.2\% = 14.4$. For a total of 49% deduction.

Example 3: A Douglas-fir has a merchantable height of 73 feet. There is a conk at the base of the tree, attached to a root. This indicates stump rot. There may also be other visible defects present, i.e., fire scars and cat faces. Use the height of the visible defect plus an additional 2 feet to determine the total length affected. If no scars are visible, use any butt swelling that may be present. With no external indicators present, extend the length affected an additional four feet. Take 4 feet off the first log. $2.3\% \times 4' = 9\%$ deduction.

Figure 38: Conks



(99-020) SCORCHED FOLIAGE

Injury: Trees that have one-sided crowns, large gaps or holes in the crown, or flattened tops (depending on species). Trees with poor crown form do not necessarily have poor crown ratios or poor growth.

(99-022) POOR CROWN FORM

Injury: Trees that have one-sided crowns, large gaps or holes in the crown, or flattened tops (depending on species). Trees with poor crown form do not necessarily have poor crown ratios or poor growth.

(99-038) CHARRED BARK

Injury: Trees that have one-sided crowns, large gaps or holes in the crown, or flattened tops (depending on species). Trees with poor crown form do not necessarily have poor crown ratios or poor growth.