

STEM DECAYS OF CONIFERS IN THE INTERMOUNTAIN REGION

Borys M. Tkacz
Plant Pathologist
USDA Forest Service
Ogden Field Office

I. INTRODUCTION: This presentation will deal with common stem decays of conifers in the Intermountain Region. Since the amount of decay is usually related to age, this class of diseases will diminish in importance as we manage forest stands to shorter rotations. However, decay will still be an important consideration where we partially cut sensitive species.

II. GENERALITIES ABOUT STEM DECAYS.

- A. Most trees compartmentalize decay.
 - 1. decay columns are limited to diameter of tree at wounding
 - 2. internal barriers are developed by the tree in response to wounding and remain in place until tree is wounded again
- B. Amount of decay increases with increase in moisture.
 - 1. greater on northerly vs. southerly aspects
 - 2. generally greater on moist habitat types
- C. Amount of decay varies by species of tree.
 - 1. greater in fir and spruce than pines

- D. Amount of decay increases proportionally with stand age and diameter.
- E. Amount of decay varies with degree of wounding.
 - 1. decay increases proportionally with frequency of tree wounding in stand
 - 2. decay increases with wound size and age
 - 3. basal wounds are associated with more decay than upper stem wounds
- F. Decay is influenced by genetics.
- G. Decay can be caused by several fungi and other microorganisms acting together.
- H. Butt rot is influenced by the distribution of root pathogens.

III. COMMON STEM DECAYS IN THE INTERMOUNTAIN REGION:

A. RED RING ROT (caused by Phellinus pini)

- 1. Hosts: Douglas-fir, pines, spruces, true firs
- 2. Entry: thought to be dead branches or stubs
- 3. Location: trunk
- 4. Key identifying features:
 - a. swollen knots
 - b. punk knots
 - c. white pockets
 - d. conks - bracketlike with a brownish-black upper surface having concentric furrowed rings and a brown undersurface with pores
 - e. rot column in rings or crescent-shaped segments of rings
- 5. Cull rules:
 - a. tables available for Douglas-fir and white pine that show deductions for conks on different age trees

B. RUST-RED STRINGY ROT (caused by Echinodontium tinctorium)

- 1. Hosts: True firs and hemlocks
- 2. Entry: Dead twigs less than 2 millimeters in diameter
- 3. Location: trunk

4. Key identifying features:
 - a. conks - hoof shaped, hard and woody: upper surface rough, black furrowed, and cracked; lower surface covered with coarse, hard grayish spines; interior brilliant rust or brick red
 - b. stringy, fibrous rot
 - c. rusty punk knots (not swollen)
5. Cull rules:
 - a. tables available for white and red fir in SW Oregon that relate deductions to number and locations of conks

C. SCHWEINITZII BUTT ROT (caused by Phaeolus schweinitzii)

1. Hosts: Douglas-fir, pines, spruce, true firs
2. Entry: roots and basal scars
3. Location: butt and roots
4. Key identifying features:
 - a. swollen butt
 - b. conks - annual, moist and cheesy when fresh; upper surface reddish brown, velvety with concentric rings and a light yellow margin; occur as thin brackets at tree base or as irregular saucers on nearby ground
 - c. cubical rot in late stage of decay with thin felts between cubes
 - d. Cull rules:
 - (1) if conk on scar at base deduct 8 feet of butt log for young growth and 16 feet of butt log for old growth
 - (2) if conk on a scar 8 feet or more above ground deduct 32 feet

D. BROWN CRUMBLY ROT (caused by Fomes pinicola)

1. Hosts: all important conifers
2. Entry: in living trees, through wounds or dead tops
3. Location: variable in living trees, around wounds
4. Key identifying features:
 - a. brown cubes in late stage
 - b. usually in old logs and dead trees
 - c. sapwood as well as heartwood affected

- d. conks - perennial, hard, tough, and hoof shaped; upper surface smooth, zoned in gray to black with a reddish band just inside a white margin
- 5. No cull rules have been established (usually occurs only on dead wood).

E. TOMENTOSUS ROOT ROT (caused by Inonotus tomentosus)

- 1. Hosts: Spruces, Douglas-fir, lodgepole pine
- 2. Entry: through roots or root wounds
- 3. Location: butt log
- 4. Key identifying features:
 - a. declining crowns
 - b. red stained wood-- early stage
 - c. pitted decay - late stage
 - d. conks (rare) - mushroom shaped, small; yellow to rusty-brown velvety upper surface; the undersurface is a white to light brown tube layer
- 5. Cull rules: defect limited to lower 6 feet

IV. MANAGEMENT RECOMMENDATIONS FOR MINIMIZING STEM DECAYS

A. Manage on short rotations

B. Select crop trees based on the following characteristics:

- 1. at least 50% live crown ratio
- 2. good current leader growth
- 3. no wounds or top damage
- 4. best form and height

C. Minimize wounding during partial cutting:

- 1. restrict the operating season
- 2. restrict the size and type of operating equipment
- 3. mark "leave" rather than "cut" trees
- 4. plan skid trails before logging
- 5. match log lengths to final spacing
- 6. log skid trails first
- 7. cut low stumps in skid trails
- 8. use directional falling
- 9. limb and top trees prior to skidding
- 10. remove slash from around trees if stands are to be underburned
- 11. gain the cooperation of the operator

D. Wound dressings are bad news!

TRUNK ROTS IN CONIFERS

BROWN STRINGY ROT

Hosts: white fir

Causal fungus: Indian paint fungus (Echinodontium tinctorium)

Indicators: Perennial conks (one to six or more) on trunk, issuing under dead branch stubs or at knots.

Conks: Rough and blackish on top, grayish and toothed or spiny underneath; a light brick or rusty red interior; 3 to 12 inches wide.

Place of infection: Dead twigs < 2mm diameter

Rot: Late stages stringy; rusty brown, although basically classified as white rot.

This rot causes occasional failures in old firs, almost exclusively during severe winter storms. The size and distribution of the conks gives a rough index of the stage

and extent of the rot within the tree. Conks less than half a foot across are ordinarily young and indicate that the rot at that point has probably not yet reached an advanced stringy stage unless the affected tree is small and suppressed. Larger conks indicate that the fungus has long been established in the tree and that the rot is in the late stringy stage, extending for many feet above and below the conk. Extensive decay is also indicated by conks widely spaced along the same trunk, more than 10 feet vertical distance separating between upper and lower conks.

The decay is restricted to the hardwood and in some instances may not affect the entire cross section of the heartwood column. The degree of weakening depends much upon the width of the sapwood which in turn is governed chiefly by the rate of diameter growth of the tree.

MOTTLED ROT

Hosts: White fir (also occurs on several hardwood species).

Causal fungus: Yellow cap fungus (Pholiota adiposa).

Indicators: Annual conks.

Conks: Mushroomlike, yellow, with gills on the under surface, soft, short-lived. Appears in clusters through bark crevices or at edges of open wounds after fall rains.

Place of infection: Chiefly through open wounds or dead areas such as fire wounds and the exposed wood of dwarf mistletoe cankers.

Rot: Late stages whitish, mottled with brown, narrow, irregular channels or pits in the decayed parts.

Mottled rot that has become established through open basal fire wounds may extend up in affected trunks for as much as 50 to 60 feet. The rot developing in the dead parts of open dwarf mistletoe cankers is usually localized in the cankered portion of the trunk swelling. Except for locations where exposed dead sapwood is present, the decay is confined to the heartwood. In old infections the rot may collapse, leaving a hollow butt.

The weakening effect on a tree trunk thus depends on the thickness of the zone of live sapwood outside the decayed heartwood and the relation of this width to the total radius of the trunk at the level of maximum rot development.

BROWN CUBICAL ROT

Hosts: Hardwoods.

Causal fungus: The sulfur fungus (Polyporus sulphureus).

Indicators: Conks appearing from openings in the trunk, usually near the tree base. The conks are annual in that they last for only one season, but do not develop every year.

Conks: Clusters of thin, shelf-like fruiting structures, soft when fresh; bright orange on top and bright sulfur-yellow underneath; becomes hard and brittle upon aging, changing to a chalky or grayish white. Broken remnants of this stage may persist on the trunk for some months. Size variable, but usually eight inches or more wide.

Place of infection: Chiefly through open trunk wounds or dead branch stubs.

Rot: A brown cubical heart rot, usually centering near the base of affected trees.

TRUNK ROTS IN HARDWOODS

Because of the difference in tree form in the hardwoods as compared to conifers, most trunk rots in hardwoods also extend into the main branches, where they may cause greater weakening than in the main trunk. Two of the three decays listed below are found chiefly in oaks.

WHITE POCKET ROT ("PIPED" ROT):

Hosts: Oak.

Causal fungus: Polyporus dryophilus.

Indicators: Conks or their remains; rot of the fungus showing through trunk or main lateral openings.

Conks: Light brown, darkening somewhat with age, usually hoof-shaped, up to six inches wide; issuing at knots or open wounds. A hard gritty core persists for many weeks after the balance of the conk has eroded away.

Place of infection: Mostly through broken branches or open wounds.

Rot: Consisting of long, narrow white pockets in the heartwood, running together longitudinally. The rot may ultimately collapse partially, creating irregular hollows within affected heartwood. Confined to the heartwood, usually of the upper trunk and main branches.

Breakage of trunks or main branches because of its presence occurs almost exclusively during severe windstorms or, more commonly, from the weight of clinging snow in snowstorms.

BROWN CUBICAL ROT

This rot is described in the section on trunk rots in conifers. In oaks, this decay is almost always confined to the lower trunk because the fungus becomes established chiefly through basal fire wounds. But it may occasionally center higher up in the trunk. The rot is confined to the heartwood, but usually involves the entire heartwood cross section. The presence of the rot is usually detectable within open basal wounds.

WHITE TRUNK ROT

Hosts: Aspen

Causal fungus: False tinder fungus (Phellinus tremulae)

Indicators: Perennial conks on affected trunks.

Conks: Common on affected trees, from one to many per tree, emerging at knots and branch stubs. Hoof-shaped, 2-8 inches wide, upper surface grayish black, rough and cracked, under surface brown with small circular pores, interior is rusty brown, showing many layers of tubes.

Place of infection: Branch stubs, knots and open wounds on trunks.

Rot: A soft whitish rot in the advanced stage, rather uniform in texture with fine black zone lines running irregularly throughout. Not collapsing or forming hollows, confined to heartwood. It may be prevalent in some stands but absent in others. It rarely causes failure in affected trees, in part because the rot never collapses to form hollows within affected trunks and in part because the proportion of heartwood to sapwood is usually not as large in aspen as in mature trees of many other native tree species.

ROOT AND BUTT ROTS

SHOESTRING ROOT ROT

Hosts: has wide host range: many hardwoods, i.e. oaks, cottonwood, aspen and most conifers.

Causal fungus: Armillaria sp.

There are several species of Armillaria, but we don't know which ones are in Utah! Recent research indicates that some species attack only hardwoods and others conifers and hardwoods.

Indicators: Flattened black rhizomorphs ("shoestrings") over bark below ground level or between bark and wood in dead areas. Conks (fruitbodies) when present.

Conks: Mushroomlike, appearing in clusters at the ground line around the base of infected trees after fall rains or in the spring. Color varies from honey yellow to dark smoky gray. Soft and fleshy, short lived. Under surface with radiating gills rather than pores.

Place of infection: Through basal wounds or by way of roots.

Rot: In the advanced stage, whitish, soft and spongy. Often becoming somewhat stringy in conifers traversed by irregularly distributed black zone lines in most cases.

The causal fungus of this rot can decay physiologically dead wood, such as heartwood, and also can kill live wood. It is often associated with the roots and butts of decadent trees. Affected trees may eventually fail at the base, either during strong winds or under perfectly calm, still conditions. Several accidents or near accidents in campgrounds or similar heavily-used recreational areas have been traceable to the destruction of wood in roots and tree bases by this fungus.

In infected bark, small, thin white mycelial plaques are formed within the bark layers when the fungus is active. In hardwood bark, the mycelium of these plaques has a fan-shaped pattern, but in conifers the pattern is usually straight and parallel. Concurrent with formation of the plaques, a felt of white mycelium develops between the bark and wood at the butt of infected trees.

A unique feature of the fungus is the formation, in well established cases, of flattened blackish fungus structures known as rhizomorphs. Their appearance suggests black shoestrings, hence the common name of "shoestring fungus." They usually appear either over the outside of the bark below ground level, or form between wood and bark if patches of bark have been killed and have separated from the wood. No other native butt and root rot fungus in the west produces such structures. Accordingly, if found, they provide positive evidence of the presence of the Armillaria fungus.

The fungus destroys the basal heartwood of affected trees, but usually does not extend up in the trunk in the heartwood for more than ten feet. A hollow is often formed in the butt from collapse of the decayed wood there. The basal sapwood near ground level may also be invaded and killed, along with the overlying bark, but not uniformly. Thus, killing sapwood may be in progress along one part of the circumference of the tree near ground level, but not along other parts. A tree often may fail in the absence of wind, either in the evening or early morning hours after a moderately warm, dry day.

ANNOSUS ROOT AND BUTT ROT

Hosts: White fir and subalpine fir; occasional in Douglas fir and spruce. Also attacks and kills ponderosa, Jeffrey, and other pine species, but without causing a butt rot in them as it does in the firs.

Causal fungus: The Fomes root fungus (Fomes annosus).

Indicators: The relatively characteristic rot showing in open basal wounds. Sometimes crown deterioration evidenced by the presence of scattered dead twigs and branches when not caused by dwarf mistletoe; and by reduced foliage growth.

Conks: Irregular in shape. In firs developing only within the hollow butts of trees badly decayed by the fungus, often at ground level or below. Perennial, whitish to light brown when fresh, tough corky in texture, later darkening and hardening. Shreds of old decayed wood are often incorporated into the conks.

Place of infection: Usually through open basal wounds such as fire wounds. May also enter through roots.

Rot: In the advanced stage in fir, white, soft, and stringy, with white pits, these sometimes showing black centers. The rot often eventually collapses in the butt, forming a hollow. Chiefly confined to the heartwood, but may extend into the roots or part of them.

In some native pines of Utah, this fungus is an active killer, especially around stumps in which it has become established. But in the true fir and Douglas fir the fungus does not ordinarily invade or kill the butt sapwood. It

often extends into part of the roots, however, and is a source of windfall in the fir. Most windfall in fir takes place during windstorms, but occasionally affected fir fall on windless nights, usually following a warm dry day.

The rot may extend up through the heartwood from basal wounds for as much as 10 feet in Utah. Conks of this fungus in firs are almost always hidden within basal hollows and are thus of little help in identifying the presence of the fungus in standing trees. The fungus takes many years to weaken the base of affected trees enough to make them possible hazards.

In inspections for hazardous trees, suspect this fungus in any hollow-butted true fir in which the hollow is large, extends well below ground level, and is associated with a white soft rot. If the crown is also decadent, with scattered old and recent dead branches, the *Fomes Annosus* is almost sure to be present in the main roots.

RED-BROWN BUTT ROT

Hosts: Douglas fir, various pines.

Causal fungus: The velvet top fungus (*Polyporus schweinitzii*).

Indicators: Conks at tree butts or from ground near the butts, brown cubical rot showing in open basal wounds.

Conks: Shelf-like when attached to the butts of trees. Roundish, with depressed centers and short central stalks when arising through the soil from roots, often multiple. Reddish brown above, greenish yellow underneath when fresh, under surface turning brown when bruised, changing to chocolate or blackish brown in age. Annual, but the conks persist after death, not destroyed by insects.

Place of infection: commonly through roots.

Rot: A yellow-brown to red-brown cubical rot, breaking into large chunks. These are divided at intervals by thin, crust-like resin-colored fungus layers. Confined to heartwood, usually of butt and roots.

B. SEQUENCE OF ROOT DISEASE SYMPTOMS:

1. reduced height growth,
2. thin crowns,
3. yellowing foliage,
4. dying of branches,
5. production of distressed cones,
6. death or windthrow.

C. SUSCEPTIBILITY TO INFECTION BY ROOT DISEASES VARIES WITH TREE SPECIES.

V. ANNOSUS ROOT DISEASE (caused by Fomes annosus)

A. INFECTION:

1. infection occurs by windborne spores produced on conks in decayed stumps or on roots of windthrown trees,
2. the spores infect freshly cut stumps or basal wounds,
3. spore deposition trends vary with climatic characteristics of the area:
 - a. warm/dry - peak during winter
 - b. cool/moist - peak in autumn
 - c. short peaks follow summer rains.
4. although most conifers are susceptible to infection there are different strains of the fungus that have specific host preferences:
 - a. fir strain - will spread from fir stumps to fir regeneration but not to pines,
 - b. pine strain - will spread from pine stumps to pine or fir regeneration.

B. SPREAD:

1. grows through roots and decays wood,
2. infects healthy roots through contact,
3. produces expanding centers which enlarge by about 1.5 ft/yr,
4. persists in large infected snags and stumps for 40 years or more,
5. stumps less than 18 inches in diameter seldom act as infection foci.

C. EFFECTS:

1. direct mortality (mainly saplings and smaller trees,
2. predisposition to insect attack:
 - a. fir engraver - grand fir,
 - b. western balsam bark beetle - subalpine fir,
 - c. Ips, mountain pine beetle, western pine beetle - ponderosa pine.
3. windthrow - butt/root decay.

D. MANAGEMENT GUIDELINES

1. Avoid damaging the cambium:
 - a. avoid logging injury,
 - b. avoid damage during underburning.
2. Reduce the number of entries:
 - a. fewer wounds,
 - b. heavier PC thin
 - (1) smaller stumps
 - (2) postpone first CT.
3. Shorten rotation:
 - a. limit exposure to disease
 - b. smaller stumps - lower survival of fungus
 - c. salvage imminent mortality.
4. Promote a mixed species stand:
 - a. be aware of which strain is present,
 - b. encourage pine regen. around infected fir stumps.
5. Minimize stress - decline and insect attack hastened by:
 - a. drought
 - b. overstocking
 - c. off-site management
 - d. other pests
 - e. air pollution
6. Treat stumps with Borax to prevent infection:
 - a. recommended for pine stumps larger than 18 inches,
 - b. only needed within 1 mile of heavily infected pine stands,
 - c. uncertain for fir (except in recreation areas),
 - d. must be done within two days of cutting,
 - e. will not eradicate fungus from already infected stumps!
7. Reduce the amount of inoculum (remove infected stumps):
 - a. limits underground spread,
 - b. reduces infection of regeneration,
 - c. decreases time disease is active on site,
 - d. allows colonization by antagonists.

VI. ARMILLARIA ROOT DISEASE (caused by Armillaria obscura)

A. INFECTION:

1. occurs primarily by rhizomorphs (fungal strands) as well as by root contacts,
2. success of infection dependent on host vigor as the "inoculum potential" (the energy of growth of a parasite available for infection of a host),
3. infections on lateral roots often result in resinous lesions and death of distal portions,
4. rapid colonization of cambial region can occur

if host is weakened by multiple infections on lateral roots, attacks by other pests, or generally unfavorable conditions.

5. lethal attacks on saplings or poles are regularly located high on the tap root or at the root collar,
6. all conifers are susceptible but at varying degrees,
7. in northern Idaho, the fungus was nearly always present in cool and moist to warm and moist habitat types and was absent in cold and dry, hot and dry, and frost pocket habitat types.

B. SPREAD:

1. can survive as long as 35 years in old-growth stumps and roots,
2. survival is affected by tree size, species, habitat type,
3. spread to healthy roots by contact or rhizomorphs which are capable of growing several feet through soil,
4. center expansion rate variable: can be 1-3 ft/yr.

C. EFFECTS:

1. decay,
 - a. butt log cull
 - b. windthrow
2. growth loss
3. direct mortality (especially seedlings and saplings)
4. predisposition to insects (similar to annosus)

D. MANAGEMENT GUIDELINES: Effective and practical treatments to minimize damage are based on increasing host vigor, favoring disease-tolerant species, or minimizing inoculum.

1. Stand establishment:
 - a. record location of infected stumps from previous stand,
 - b. consider removing infected stumps,
 - c. use natural seeding of preferred tree species,
 - d. if planting use seed sources adapted to the area,
 - e. minimize practices that lead to poor root development.
2. Sapling stands:
 - a. map locations of disease when stands are 10-15 years old,
 - b. thin infected stands having excessive

- stocking to increase tree vigor,
- c. favor disease-tolerant species during thinning,
- d. patch cut severely diseased portions of stands where enough crop trees are not present for an adequately stocked stand and reforest with a more disease tolerant species.
- 3. Pole and small sawtimber stands:
 - a. map locations of centers,
 - b. if disease not severe (less than 20% area):
 - (1) thin normally in healthy parts,
 - (2) treat centers plus 50 foot buffer.
 - c. if disease severe (greater than 20% area):
 - (1) do not thin,
 - (2) clearcut if net volume increment is below minimum acceptable level.
- 4. Large sawtimber stands:
 - a. map centers during sale layout,
 - b. clearcut if net volume increment is below minimum,
 - c. remove stumps if regenerating with susceptible species.

VII. TOMENTOSUS ROT DISEASE (caused by Inonotus tomentosus)

A. INFECTION AND SPREAD:

- 1. most common hosts are blue and Englemann spruce (also occurs on Douglas-fir and lodgepole pine),
- 2. main means of infection and spread is by root contacts,
- 3. spores can infect wounded roots with exposed heartwood,
- 4. spread rate is slow, averaging 5 inches/yr.,
- 5. fungus can persist in large dead roots and stumps for at least 20 yrs.,
- 6. dead, deformed roots resulting from poor planting can lead to infection.

B. EFFECTS:

- 1. decay
- 2. growth loss
- 3. direct mortality (mainly smaller trees),
- 4. predisposition to insect attack:
 - a. spruce beetle - spruce
 - b. Douglas-fir beetle-Douglas-fir

C. MANAGEMENT GUIDELINES

- 1. favor less susceptible trees during thinning and planting,

2. cutting boundaries should extend at least 50 feet beyond symptomatic trees,
3. care should be taken to avoid damaging roots of susceptible species,
4. infected stumps can be removed from heavily infected areas when regenerating with susceptible species,
5. infection centers can be converted to aspen for a rotation to allow fungus to die out of roots and stumps.

VIII. SCHWEINITZII ROOT AND BUTT ROT (caused by Phaeolus schweinitzii)

A. INFECTION AND SPREAD:

1. found most frequently on Douglas-fir (also occurs on pines, spruces, and true firs,
2. affected trees typically show no outward symptoms,
3. fruiting structures form on trees with extensive advanced decay,
4. most infection takes place through root tips (not basal fire scars as once believed),
5. the fungus becomes confined to root and stem interiors,
6. most tree-to-tree spread is by mycelia growing through soil litter.

B. EFFECTS:

1. extensive decay of tree butts,
2. wind breakage above groundline,
3. predisposition to bark beetle attack.

C. MANAGEMENT GUIDELINES:

1. reduce rotation age to 90-100 years,
2. regenerate the site to less susceptible conifers.

IX. BLACK STAIN ROOT DISEASE (caused by Verticicladiella wagneri)

A. INFECTION AND SPREAD:

1. most common host in R4 is pinyon pine (in other regions also found on Douglas-fir, hemlock, lodgepole pine, and ponderosa pine),
2. long distance spread may involve insect vectors,
3. local spread is mainly via root contacts or grafts,
4. infection occurs regardless of host vigor,
5. rate of spread is rapid (3-6 feet per year in PNW),
6. fungus does not persist after host dies.

B. EFFECTS:

1. direct mortality - often associated with disturbance,
2. predisposition to bark beetles,
3. does not decay wood.

C. MANAGEMENT GUIDELINES:

1. favor nonhost species in infection centers,
2. do not thin when vectors are active (early spring),
3. minimize site disturbance and tree injury,
4. clearcut infection centers plus buffer of healthy trees.

LIMB RUST (Peridermium filamentosum)

Limb rust is a pine killing disease in the western United States and south to Guatemala. Limb rust is a systemic disease. Infection can spread throughout a tree rather than being restricted to a gall or canker. The fungus grows into the bole from the branch originally infected. Once a tree is infected there is no way to stop the killing process. Death is a result of photosynthetic tissue loss and energy demands by the fungus. Death is slow, it comes after 80-90 percent of the crown is lost. Heavily infected trees are often killed by bark beetles. Linear spread of the fungus is approximately 1.5 feet per year.

BARK BEETLES

Bark beetles are considered the single most damaging pest in coniferous forests of the intermountain west in recent years. Bark beetles normally attack trees that are in a weakened condition (mature, overcrowded, drought, diseased). This is nature's way of weeding out the weak to maintain a healthy forest. In areas impacted by humans you will often find a higher concentration of beetles. The insects bore into the tree feeding on the cambium layer. The insect creates a gallery and lays its eggs. Once the eggs hatch, they evolve from larvae to callow adults, then adults. During this process the insect is feeding on the cambium layer. The adult finally emerges and flies to the next tree selected. The process from initial attack until the adult leaves often times will girdle the tree. Stain fungi introduced by the beetles aid in plugging the conducting tissues within the tree. This disrupts the flow of needed nutrients and water causing the tree to die.

MANAGEMENT OF BARK BEETLES

John Anhold, Entomologist
USDA Forest Service
Forest Pest Management
Ogden Field Office

I. INTRODUCTION:

This presentation will center around the most destructive insects in western coniferous forests, Bark Beetles. These beetles kill billions of board feet of sawtimber annually. Three species of *Dendroctonus* - mountain pine beetle, Douglas-fir beetle, and spruce beetle - cause most of the destruction. *Ips* beetles, often found in slash, can kill smaller trees and tops of trees. Most of the time, the greater portion of the killing is the result of endemic infestations that are continuously present in mature forests. Under conditions favorable for the beetles, epidemics occasionally develop and spread over large areas, killing vast amounts of timber and setting the stage for devastating fire.

II. GENERALITIES ABOUT BARK BEETLES

A. Bark Beetles Typically:

1. Colonize trees under some type of stress
 - a. drought
 - b. defoliation
 - c. root diseases etc.
2. Are present in every stand at the endemic level

B. Attacking Behavior

1. Depending on weather, may take place for a month or more. Most flight activity within a week.
2. Flight capacity & distances flown
 - a. under epidemic conditions, flight distance & time may be short.
 - b. under endemic populations conditions, flight distances may be greater.
 - c. dependent on abundance of suitable hosts in proximity
3. Host selection
 - a. key in on stressed trees, olfactory cues
 - b. visual cues, particularly vertical objects
 - c. feed or sample phloem for some stimulant(s) for continued feeding
4. Concentration - mass attack
 - a. pioneer adult females release aggregate pheromone-trans-verbenol
 - b. host produced monoterpene, myrcene
 - c. arriving males produce exo-brevicomin, aggregative
 - d. anti-aggregative pheromone released with overcrowding
5. Establishment
 - a. dependent on the rate of inoculation & development of associated blue stain fungi
 - b. fungi create conditions suitable for brood development

C. Pest population treatments - Past & Present

III. MOUNTAIN PINE BEETLE (*Dendroctonus ponderosae*)

The mountain pine beetle is one of the most destructive insect pests of pines in western North America. This insect has one generation annually and attacks both lodgepole and ponderosa pines. Larvae feeding beneath the bark of various host pines eventually girdle and kill the trees.

A. Hazard Rating

1. Rating systems available
2. Other factors influencing hazard
 - a. root disease
 - b. defoliators: pine tortrix, pine butterfly
 - c. drought
 - d. development, roads, campgrounds
 - e. abundance of bark beetles in proximity
3. Stand density index (SDI), an indicator of potential mortality
 - a. phloem thickness & density
 - b. % attack & density
 - c. application of density management diagram

B. Management Guidelines

1. Chemical treatment, carbaryl - sevimol, temporary action, effective for 2 years
2. Biological treatment
 - a. birds, insects, & nematodes - effective when beetle population is in endemic levels
3. Cultural treatment
 - a. thinning to enhance stand/tree vigor, increase resin flow & production
 - (1) LPP - <80 years & <8" d.b.h.
 - (2) PP - 100-120 years, <8-12" d.b.h., BA 80-100
 - b. drainage diversity - create age mosaics throughout a large area
 - c. species diversity - break up large monostructures
 - d. salvage - remove infested trees before brood matures
 - e. trapping - limited success

IV. DOUGLAS-FIR BEETLE (*Dendroctonus pseudotsugae*)

The Douglas-fir beetle infests Douglas-fir throughout most of the range of that tree in western North America. This insect has one generation per year with adult beetles emerging and flying to new host trees from April through June. Adults like to build up in down material. Larvae feeding beneath the bark of host trees eventually girdle and kill the trees.

A. Hazard Rating

1. Density, age, % D-fir, and diameter
2. Other factors influencing hazard
 - a. blow down
 - b. defoliators: budworm, tussock moth
 - c. fire scorched trees
 - d. root diseases

B. Management Guidelines

1. Chemical treatment
2. Biological treatment
 - a. disaggregation pheromones - MCH (methylcyclohexenone)
 - b. birds, insects, & nematodes
3. Cultural treatment
 - a. rotation, limit rotation to 120 years
 - b. mixture of host & non-host tree species
 - c. prompt removal of cut host trees, log decks
 - d. slash management - cull logs & large slash are potential beetle breeding sites. Remove or buck into short lengths 18"
4. Salvage - prompt removal of infested, snow broken, and wind thrown trees, remove before

November 1 year of attack

5. Trap trees - high risk host trees can be fallen and removed following colonization & before brood matures

V. SPRUCE BEETLE (*Dendroctonus rufipennis*)

The spruce beetle infests spruce species throughout most of their range in western North America. This insect generally has a two year life cycle with adult beetles emerging and flying to new host trees usually in June and July. Occasionally a one year life cycle is observed at lower elevations. Here again adults key in on down material. Larvae feeding beneath the bark of host trees eventually girdle and kill the trees.

A. Hazard Rating

1. Physiographic location, dia. > 10", basal area, % spruce
2. Other factors influencing hazard
 - a. blow down
 - b. snow damage
 - c. root diseases

B. Management Guidelines

1. Chemical treatment
 - a. lindane, temporary action
2. Biological treatment
 - a. disaggregation pheromone, MCH
3. Cultural treatment
 - a. density, limit basal area to under 150 ft and dbh < 16"
 - b. species diversity, mixture of host & non-host tree species
 - c. logging - prompt removal of cut host trees
 - d. slash management - cull logs, stumps & large slash are potential breeding sites, remove or buck into short lengths 18"
 - e. salvage - prompt removal of infested, snow broken and wind thrown trees, remove within 12-18 months after infestation
 - f. trap trees - uninfested high risk host trees can be fallen and removed after colonization, but before brood matures

VI. PINE ENGRAVER BEETLE (*Ips pini*)

The pine engraver is a common beetle infesting ponderosa and, to a lesser degree, lodgepole pine in North America. In the Intermountain Region the insect often has three flight periods annually. The insect often builds up in slash or blowdown and then preferentially attacks polesize stressed trees. Larvae feeding beneath the bark of host pines eventually girdle and kill entire trees or tree tops.

A. Generalities of Ips Beetles

1. Secondary beetle - develops in wind thrown trees, freshly cut logs, slash, and tops & limbs of trees killed by Dendroctonus beetles
2. Multiple generations per year
 - a. population size can escalate where suitable host material is plentiful
3. Outbreaks are of short duration, seldom last more than one season

B. Management Guidelines

1. Chemical treatment
 - a. sevimol, temporary action, approximately 2 years
2. Biological treatment
 - a. birds, insects & nematodes are present but have minimal effect on population
3. Cultural treatment
 - a. density, stocking control is an important factor in maintaining tree vigor
 - b. timing of management activities
 - (1) minimize the creation of slash from Dec-June
 - c. slash treatment - if mgt. activities cannot be optimally timed, measures to treat slash by burning, cut and scatter into openings to promote drying
 - d. salvage - remove infested trees before the brood matures

