Bark Beetles They're Back!!

Are Your Trees at Risk?

Many species of bark beetles are causing widespread tree mortality throughout the Intermountain West. Although sometimes viewed by humans as catastrophic, outbreaks of native forest insects are natural events. Native insects and the plants they use for food and reproduction have evolved together. Unlike some introduced pests, native insects kill individual trees but do not threaten the existence of an entire plant species. Native insect outbreaks only pose a problem when they conflict with human resource values for a particular area (i.e., recreation, aesthetics, wildlife habitat, wood production, property values, etc). A tree in the wilderness is not subject to the same human values as a tree in your backyard.

FADING TREES ATTACKED BY BARK BEETLES

Bark beetle populations have increased in forested areas of the western U.S. An abundance of larger-diameter trees in dense stands across broad landscapes and periodic drought have caused this increase in bark beetle populations.

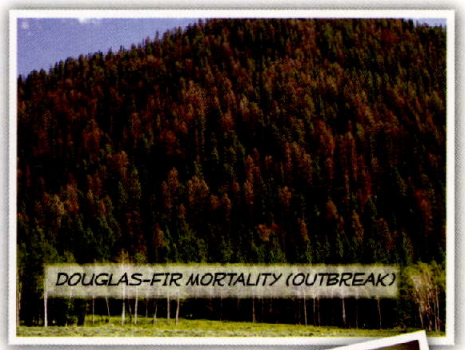
Bark beetles causing widespread mortality in the forests of the Intermountain West are all native. Principal species include: mountain pine beetle, spruce beetle, Douglas-fir beetle, western pine beetle, fir engraver, western balsam bark beetle, pine engraver, and pinyon ips.

HOW CAN SOMETHING SO SMALL KILL SOMETHING SO BIG?

These insects are small, brown and often difficult to see since most of their life is spent under the bark. Individual bark beetles are about the size of a grain of rice. In low numbers (latent populations) bark beetle populations are often associated with newly dead, dying or stressed trees caused by wind, snow, lightning, disease, feeding by other insects, or damage created by human activities. Single-tree and small-group mortality widely dispersed over the landscape is associated with these low level populations.

Beetle populations rise as susceptible hosts become more abundant. Disturbance (i.e. drought, windthrow, fire or insect defoliation) often initiates this population increase. Over large susceptible landscapes abundant tree mortality can occur, often affecting most, if not all, of the overstory trees.

When beetle populations are low, healthy and vigorous trees produce sufficient resinous pitch to drown or "pitch out" attacking adult insects. As trees become stressed, pitch production declines and the number of successful beetle attacks increases. During bark beetle outbreaks, however, even healthy trees are overwhelmed by many adult beetles "mass attacking" the tree. In addition to damage created by the beetles and their offspring, many beetles also harbor fungi that further limit the tree's ability to transport needed nutrients and water.



DOUGLAS-FIR MORTALITY (OUTBREAK)

A "PITCHOUT"

A DOUGLAS-FIR BEETLE

This publication is a collaborative effort between Forest Health Protection and National Forests to inform the public about tree-killing bark beetles, emphasising the northern Rocky Mountain and Intermountain regions (Utah, Nevada, western Wyoming, Idaho and Montana).

This information will assist you in identifying probable causes of tree mortality and determining your treatment options. It also lists contact information for your respective State and Federal Forest Health Specialists and other sources of information available to the public.

Does this affect you? Look inside

Forest Health Protection

Are Your Trees at Risk to Bark Beetles? What Should You Do?

STEP 1: IDENTIFY YOUR TREES

The first step in determining whether or not your tree is susceptible to insect attack is to know what species of tree you have. The following lists are the principal evergreen species found in the Intermountain West and Northern Rocky Mountain regions.

PINES (NATIVE):

Most pines have more than one needle attached to the tree together in a "bundle". The number of needles per bundle is often important in determining the pine species.

PINYON (COLORADO AND SINGLELEAF)

Colorado pinyon, found mainly in Utah have two, 1-2" long needles per bundle. Singleleaf pinyon, found mainly in Nevada, have one sharp, rounded needle per bundle, >1" long. Cones are not spiny.

Natural Range: Colorado pinyon in UT; Singleleaf pinyon in NV, western edge of UT, scattered spots in southern ID.


COLORADO PINYON

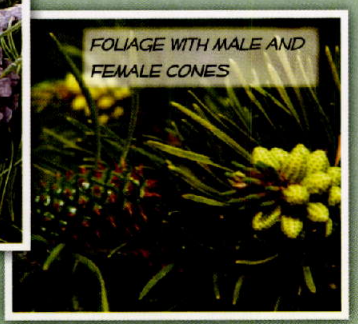

SINGLELEAF PINYON

LODGEPOLE

Needles are two per bundle, 1-3" long. The small ¾-2" long cones have very short stalks and stay attached to the tree for many years. Cones feel prickly.

Natural Range: ID, MT, WY, northern UT, spots along the Sierra Nevada Range in NV.


CLOSED AND OPEN CONES

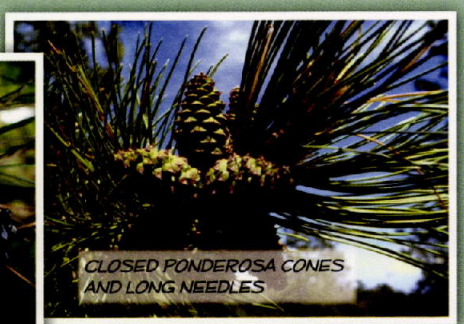

FOLIAGE WITH MALE AND FEMALE CONES

PONDEROSA (AND JEFFREY)

Ponderosa needles are 2-3 to a bundle, ranging from 3-10" in length. Cones are 2-6" long and prickled. Jeffrey pine (3-needles) is found along the Sierra Nevada's, overlapping with ponderosa pine's broad range. Jeffrey generally has larger, stouter cones (5-9") with incurved spines (pokey ponderosa; gentle Jeffrey).

Natural Range: ID, MT, UT, spots in eastern NV and the Sierra Nevadas, isolated spots in WY.

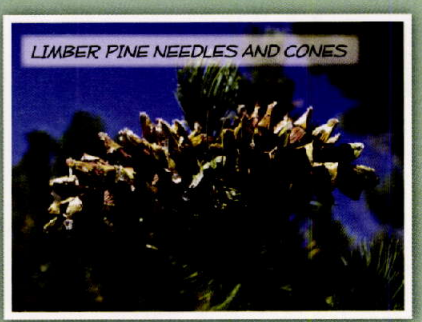

OPEN PONDEROSA CONES


CLOSED PONDEROSA CONES AND LONG NEEDLES

5-NEEDLED (E.G. LIMBER, WHITEBARK, AND WESTERN WHITE PINES)

Several pine species with 5-needle bundles are native to the Intermountain West, but Limber is the more commonly planted species around homes. Needle length ranges from 1.5-4". Cones vary.

Natural Range: various throughout Intermountain West.


LIMBER PINE NEEDLES AND CONES

PINES (EXOTIC):

SCOTCH AND AUSTRIAN PINES

These European pines have 2-needles per bundle, 1.5-3" and 3-6" longs, respectively. Scotch cones are smaller (1.5-2" long) than Austrian cones (2-3"). Cones of both species are not spiny (vs. ponderosa). Scotch pine is noted for the strong orange coloration of the bark.

Natural Range: As exotic species there is no native range but they can be found planted throughout the Intermountain West.

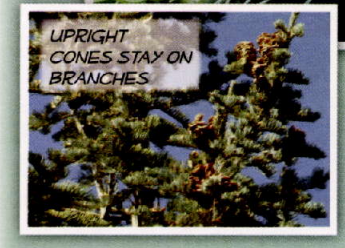
FIRS (NATIVE):

Firs and spruce have only one needle (no 'bundles') but the shape of that needle can differ by tree species.

WHITE FIR

The 2-3" long, single, flat needles narrow to a stalk at their base and have rounded tips (vs. sharp spruce or notched grand fir). The needles tend to curve upward, leaving few needles below the stem. The greenish purple or yellow cones (3-5"), found in the upper branches, point up and are not dropped. Rather, they fall apart on the tree (vs. Douglas-fir cones that drop off).

Natural Range: UT, eastern NV, southeast corner of ID.



DOUGLAS-FIR

Although not a true fir species, Douglas-fir is similar to other firs in having short (~1"), single, flat needles. Needles have rounded tips like white and subalpine fir, and are narrow at their base like white fir. However, the 3" long cones hang down. The cone scales have a distinct shape resembling the tail and back legs of a mouse.

Natural Range: ID, MT, WY, UT, and scattered spots in NV.

SUBALPINE FIR

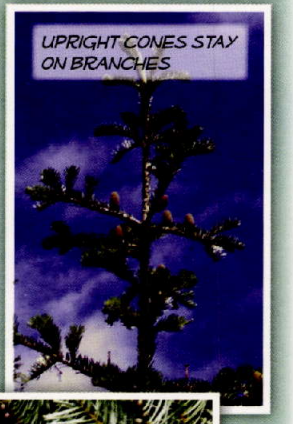
The short (1-1.5"), single, flat needles also have rounded tips but are thick at their base (vs. white fir). The dark purple cones (2.25-4" long) are borne upright on the upper branches and are not dropped.

Natural Range: ID, western MT, western WY, UT, spots in northern NV.

GRAND FIR

The single, flat needles of grand fir are 1.25-2 inches long and distinguished by having a notched end. Needles tend to grow out to the sides giving the branchlets a flattened appearance. Cones are also 2-4" long, green-brown in color, and extend upward.

Natural Range: northern two-thirds of ID, northwest edge of MT.



SPRUCES (NATIVE):

ENGELMANN AND BLUE SPRUCE

Single needles are square and sharp, leaving 'bumps' on the small twigs when they fall off. Blue spruce needles tend to be stiffer and sharper than Engelmann needles. Cones hang down, measuring 1-2.5" in length for Engelmann and 2.5-4" for blue. In the wild, blue spruce prefers moist stream edges.

Natural Range: Engelmann spruce in ID, MT, WY, UT, and NV; blue spruce in UT and WY.

References:

- Kuhns, Michael. 1998. A guide to the trees of Utah and the Intermountain West. Utah State University Press, Logan, UT
- National Audubon Society. 1996. Field Guide to North American Trees. A. A. Knopf, NY
- Watts, Tom. 1985. Rocky Mountain Tree Finder. Nature Study Guild, Rochester, NY

STEP 2:
DETERMINE YOUR TREES' SUSCEPTIBILITY

The susceptibility of an individual tree is often described differently than the susceptibility of a stand of trees. When there is a group of trees (a stand), a tree may be killed yet the overall stand may look and function much as before. In an urban setting, however, individual trees are very important for aesthetic or other urban landscape values.

INDIVIDUAL TREE SUSCEPTIBILITY

Stressed trees produce less pitch reducing the tree's ability to prevent successful bark beetle attacks. Tree stress can be caused by human activities (construction, paving, excavating, etc) or by natural causes (drought, wind, lightning, other insects or disease agents etc.). Visual symptoms associated with tree stress often include sickly looking tree crowns.

CROWN DIFFERENCES BETWEEN A HEALTHY (LEFT) AND STRESSED (RIGHT) TREE

Not all stressed trees are attacked by beetles, particularly when bark beetle populations are low. However, during bark beetle outbreaks, even healthy trees can be successfully attacked.

STAND SUSCEPTIBILITY

Dense stands composed of single-species, larger-diameter trees are most susceptible to bark beetle attacks; less-dense stands are generally more vigorous and have higher pitch production. Stands of trees stressed by prolonged periods of drought or by defoliation, disease or other damage (windthrow, fire, etc) are especially susceptible. Overall, stands that have multiple age classes, species diversity and reduced tree densities are less susceptible to bark beetle attacks and associated impacts. Even during a bark beetle outbreak not all trees in a stand are killed.

A THINNED STAND WITH A DIVERSITY OF TREE AGES

A DENSE STAND WITH TREES COMPETING FOR RESOURCES

SPECIFIC TREE SUSCEPTIBILITIES

Some bark beetles are species-specific tree killers. For instance, Douglas-fir beetle only attacks Douglas-fir trees. However, other species like mountain pine beetle will attack several species of pines.

Lodgepole, ponderosa, five-needle pines and other native and introduced pines: Most of our introduced and native western pines, with the exception of Jeffrey pine, are susceptible to mountain pine beetle attacks. **Jeffrey pine** is attacked by Jeffrey pine beetle which is very similar to mountain pine beetle. Pines susceptible to attack my mountain pine beetle are often >8 inches in diameter at breast height and weakened by drought. If populations of this insect are high, fire scorched trees are also susceptible to attack. Windthrown or downed pine trees are rarely attacked by mountain pine beetle, but are often attacked by pine engraver. In standing trees pine engraver can be found attacking trees alone or in combination with other bark beetles, particularly during periods of drought. Ponderosa pine (west of the Continental Divide) weakened by old age or other stressors (e.g. competition, lightning, root disease) are susceptible to western pine beetle. Ponderosa pine in southern Utah and Nevada may be atacked by roundheaded pine beetle.

Singleleaf and Colorado pinyon pines: Although several species of bark beetles will attack pinyon pine, the most notable for causing widespread mortality is pinyon ips. Trees stressed by drought, defoliation and fire are very susceptible to attack. Prolonged periods of drought are often the primary stress responsible for landscape level mortality associated with this bark beetle. However, slash piles created by thinning or construction of fuel breaks can increase local populations of this insect to outbreak levels.

Engelmann and blue spruce: Engelmann spruce is the preferred host for spruce beetle; although during outbreaks of this insect blue spruce will also be attacked and killed. Spruce beetle prefers larger-diameter trees (>16 inches) but will kill trees as small as 5 inches in diameter during an outbreak. Spruce beetle populations can build quickly in green downed trees resulting from windthrow or avalanche. If there is sufficient downed material allowing populations to build to outbreak levels, emerging adult beetles will attack surrounding live trees.

Douglas-fir: Douglas-fir are attacked and killed by Douglas-fir beetle. The insects prefer trees >14 inches in diameter; especially those growing in dense stands or weakened by drought, fire, root disease or defoliation. Outbreaks of this insect are often associated with fire scorched trees or an abundance of recent downed green material. Smaller trees, <8 inches in diameter may be killed by Douglas-fir pole beetle.

White and grand fir: Fir engraver is the principle bark beetle associated with these tree species. Larger diameter trees are preferred, but during periods of stress caused by drought or defoliation, trees as small as 3 inches in diameter are also killed. Attacks by this insect will not always result in tree mortality; topkill and individual branch mortality are also common.

Subalpine fir: Although fir engraver will also attack subalpine fir, particularly where it is intermixed with white and/or grand fir, most bark beetle attacks are associated with western balsam bark beetle. Populations of this insect are attracted to disease-stressed trees. Windthrown green trees are also preferred habitat for this bark beetle. Often a complex of organisms is responsible for tree mortality including bark beetles, root disease, and drought. Landscape level mortality caused by this bark beetle usually corresponds to extended periods of drought.

STEP 3:
DETERMINE IF YOUR TREES HAVE BEEN ATTACKED

Many tree symptoms and associated signs of bark beetle attack are similar regardless of the tree or beetle species involved. Some of the most common symptoms and signs are described below.

PITCH TUBES

As bark beetles bore into living trees, tree sap or pitch may be exuded from the entry hole as the tree attempts to drown the beetle. Beetles may push this pitch out their entry hole as they continue construction of their galleries, leaving small sticky tubes visible on the outside of the bark.

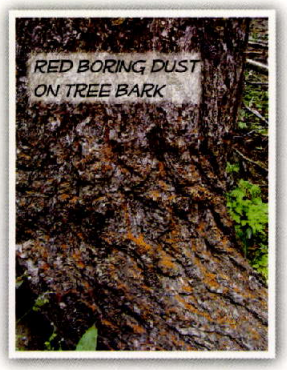
Not all tubes, however, indicate a successful attack. In some cases trees are successful in their defense and the beetles are flushed out. Unsuccessful-attack pitch tubes are often a light cream color. However, pitch tubes created when beetle attacks are successful are often reddish in color due to presence of sawdust in the pitch produced as beetles bore through the tree bark.


PITCH TUBES

Attacks by mountain pine beetle on lodgepole, ponderosa and other pines, or attacks by Jeffrey pine beetle on Jeffrey pine, are often detected early due to the presence of these highly visible tubes. Occasionally, trees produce little pitch or attacks are so high up on the tree bole that tubes are not readily visible.

BORING DUST

Whether or not pitch tubes are visible, presence of boring-created sawdust around the base of the tree or in bark crevices is a good indicator of successful beetle attack. Boring dust is the best indicator to use when trees are too stressed to produce pitch (dry attacks) or when attacks

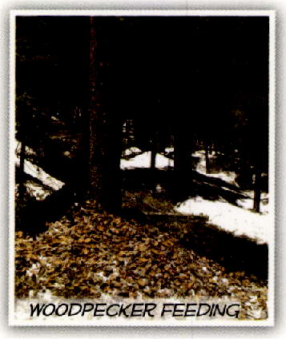

RED BORING DUST ON TREE BARK

occur higher up on the tree bole. This is often the case for mountain pine beetle or pinyon ips attacks on pines in areas under drought (dry attacks) and for Douglas-fir beetle attacks on Douglas-fir and spruce beetle attack on Englemann spruce (high attacks).

Sawdust may also be created by carpenter ants and ambrosia beetles. However, both groups bore directly into the heartwood creating a white boring dust.

WOODPECKER FEEDING

Woodpeckers and other birds foraging for beetle larvae and adult beetles will often flake off bark layers, leaving piles of bark flakes around the base of infested trees. These bark flakes are particularly visible during the winter months against the white snow. Several species of pine and Engelmann spruce are frequently debarked as these avian bark beetle predators feed.


WOODPECKER FEEDING

FADING FOLIAGE (TREE CROWNS)

Fading tree crowns are a good indicator of successful bark beetle attack. Depending on the tree species, needles will turn yellow, yellowish-green, sometimes orange and later red before they drop to the forest floor. Needle discoloration generally occurs within one year of successful attacks.


STAGES OF CROWN FADE

Photo by W. Ciesla, Forest Health International

Not all tree species will fade at the same rate following bark beetle attack, nor will all trees of the same species fade simultaneously. The speed of fading depends partly on the health of the tree prior to attack, especially its water stress level. For example, pinyon pines attacked by pinyon ips during hot dry summers may fade within 3-4 months while subalpine fir attacked by western balsam bark beetle may fade in one year and healthy Douglas-fir attacked by Douglas-fir beetle may take 2-3 years to completely fade.

Trees with red needles indicate that beetles have emerged and the tree is no longer a threat to surrounding uninfested trees. However, trees with fading needles that appear yellowish-green or yellow usually have some life stages of the bark beetle present, preparing to emerge in the near future.

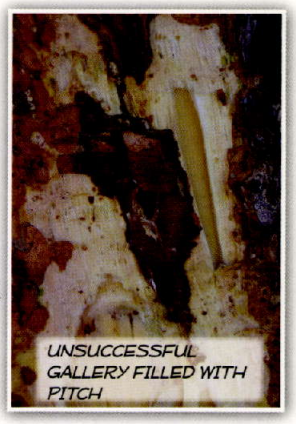
PITCH STREAMING

Trees may exude pitch for a number of reasons not related to bark beetles. Where pitch tubes are usually discrete, popcorn-shaped masses of pitch, pitch streamers are more of a long 'drip'. Pitch streamers may be created when true firs are attacked by fir engraver or western balsam bark beetle, and occasionally when Douglas-fir are attacked by Douglas-fir beetle. Although pitch streamers can be a sign of bark beetles, they should not be used as the only indicator of a successful bark beetle attack.


PITCH STREAMING

GALLERY PATTERNS UNDER BARK

Removing the outer bark in areas of the tree where beetles have attacked will: confirm an attack, determine success or failure of the attack, and identify which beetle is responsible for the attack. Each beetle species or species group (i.e. *Ips* species) has a signature gallery pattern. These specific patterns are described in 'What is a bark beetle' (pg 8+). Within successful galleries you will often find adult beetles laying eggs in the gallery or larvae feeding or pupating. Unsuccessful attacks will have incomplete galleries and often have galleries filled with pitch. However during initial stages of a bark beetle attack, the galleries are also incomplete.


UNSUCCESSFUL GALLERY FILLED WITH PITCH

STEP 4: HOW TO TREAT TREES THAT HAVE BEEN ATTACKED

Signs of successful bark beetle attack (boring dust, pitch tubes, etc) that occur on more than half of the tree's circumference generally indicate imminent tree mortality. There are no chemical insecticides shown to prevent tree mortality once adult beetles have penetrated the outer bark. If less than 50 percent of the tree circumference is infested (strip attack), preventive treatments may successfully protect the uninfested portion of the tree bole.

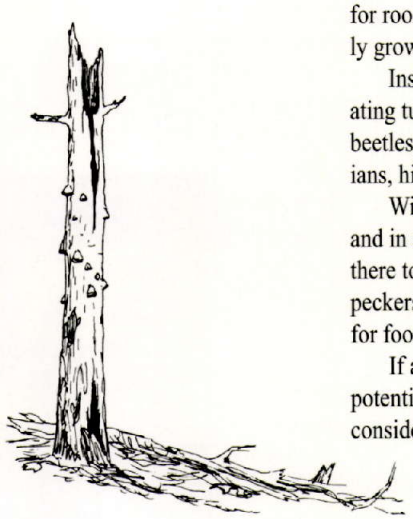
Sanitation practices to suppress populations include removing the infested tree, debarking the tree bole, and chipping or burning the wood. Cutting the tree into firewood lengths may not result in bark beetle mortality, especially if the material is shaded. However, other treatments may help dry out material before beetles can mature. For example, infested lengths of wood can be moved to sunny locations and rotated weekly, or the bark can be fully or partially removed to expose the phloem to open air. Use of plastic wrapping or tarps over infested material is not a recommended treatment method.

Infested material needs to be addressed before new beetle emerge. Because some bark beetle species have multiple generations per year (i.e. western pine beetle and ips species) you may have little time for treatment. For example, 35 days may be all that's required for pinyon ips or pine engraver to complete their lifecycle.

When needles turn reddish-brown in color, most adult beetles have left the tree. Spruce beetle may be the exception, since a portion of the population requires two years to complete its life cycle. There may be other beetles, borers and larvae in the tree but these are usually secondary insects or insect predators and pose little threat to residual green trees.

Trees with reddish colored needles or those completely void of needles can be used for firewood or left standing as wildlife trees. However, dead trees that present a hazard to existing structures or could endanger humans should be removed before they fall.

DEAD TREES ARE "HOME" TO MANY FOREST CREATURES



If enhancing wildlife habitat interests you, consider keeping dead trees on your forested lands. Standing dead trees in a forest are called "snags" and many species of wildlife depend on snags for their survival.

Owls, hawks, and eagles use snags to perch and to support their nests. Cavity nesters such as woodpeckers, mountain bluebirds, and chickadees nest in the snag cavities.

Chipmunks, squirrels, and other mammals use snags as homes. Bats use areas under loose bark for roosting. Fungi, mosses, and lichens commonly grow in the decaying wood of a snag.

Insects chew through the decaying wood, creating tunnels and chambers. Moths and ladybird beetles, and many species of reptiles and amphibians, hide under the bark of snags.

With so many animals and plants living on and in a dead tree, other animals frequently come there to feed. For example, many species of woodpeckers depend on snags to provide insect larvae for food.

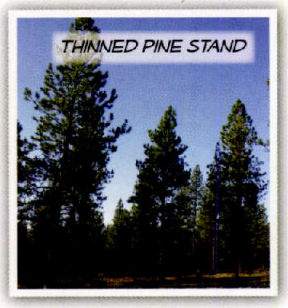
If a tree on your private land does not have the potential to endanger persons or property, please consider leaving it standing for our animal friends!

STEP 5: HOW TO PREVENT BARK BEETLE ATTACKS

Preventing successful bark beetle attacks is key to protecting uninfested trees. Once insects have entered the bark there are no effective treatments to keep the tree alive. Steps you can take to prevent successful attacks on uninfested trees include:

1. Remove all currently infested trees.
2. Always remove, chip or burn recentl- windthrown trees or wood debris that's >4 inches in diameter. Larger pieces of wood provide a more abundant food source for the beetles and produce more of the adults.

3. Avoid damaging the bark or root system of standing green trees.
4. Initiate thinning treatments to reduce stand densities, leaving a mix of age classes, tree species or both. Thinning reduces competition between trees for limited sun, water and nutrients. Remaining trees are better able to produce pitch used in the trees defense against bark beetle attacks. A mix of age classes and tree species reduces the stands susceptibility to attack and impacts caused by bark beetle outbreaks. Contact your local State Forester's office for assistance (pg. 12).



5. Increase age and species diversity to enhance stand resistance to bark beetle attacks, and reduce the effects of tree mortality when attacks occur.
6. Preventative insecticide treatments offer excellent single-tree protection if applied properly. Several formulations of carbaryl and pyrethroids are registered for bark beetle applications. There are no effective or registered insecticides for some species of bark beetles such as fir engraver and western balsam bark beetle.

Chemical Treatments

PHEROMONES

- **MCH for Douglas-fir beetle:** MCH (one-methy-cyclo-hex-3-one) is a chemical used by Douglas-fir beetle to communicate. This pheromone tells dispersing adult beetles that a tree is fully occupied and to look elsewhere for another host tree. The pheromone has been commercially synthesized and is available in small bubble caps that are easily stapled to the tree bole prior to beetle flight in early spring. These are slow release capsules that distribute the repellant pheromone over the flight period. Application rates should be 30-40 bubble caps per acre for area protection or 2+ caps per tree for single tree protection. See 'Using MCH to Protect Tees and Stands from Douglas-fir beetle Infestation' at http://www.fs.fed.us/r1-r4/spf/fhp/publications/MCH_brochure/MCH_online.pdf.

- **VERBENONE for mountain pine beetle:** Verbenone (4,6,6-trimethylbicyclo[3.1.1]-hept-3-en-2-one) is the repellant pheromone for mountain pine beetle. This pheromone is also available commercially. Recommended dosage is 2+ pouches per tree for individual-tree protection, or in lodgepole pine, 20-40 pouches per acre for area treatment. Application prior to summer beetle emergence is necessary. Verbenone treatments are generally deployed in sites where insecticide application is not feasible. Effectiveness of the verbenone treatment varies depending on beetle population pressure, number of currently infested trees and other stand conditions. Annual removal, debarking or chipping of infested trees from the verbenone treated site is recommended. Research studies are currently being conducted to improve the formulation by adding additional repellents to enhance treatment effectiveness.

- CONTACT YOUR STATE FOREST HEALTH SPECIALIST (page 12) for technical advice on administration of these treatments and to determine if financial assistance is available.

INSECTICIDES

- **Carbaryl** – Flowable formulations of this insecticide are registered and effective for several bark beetle species (mountain pine beetle, Jeffrey pine beetle, western pine beetle, spruce beetle, and ips species). These are preventative sprays applied to the tree bole before trees become infested. Generally, insecticide treatments are only used on high-value trees and applied by licensed pesticide applicators. All tree bole surfaces must be treated to the point of run-off including the trees root collar. Spray height varies from 30-50 feet depending on tree height. Although the label indicates annual treatments are necessary, research has shown that properly treated trees remain protected for 18-24 months. Your State Forest Health Specialist can assist you with treatment recommendations (page 12), and your State Department of Agriculture can assist in finding licensed pesticide applicators.

- **Other Insecticides** - Although registered pyrethroids are effective preventative treatments for some species of bark beetles, applications are generally required annually.

- **Systemic Insecticide treatments** – Systemic insecticides applied as a soil drench or delivered directly into the trees bole have not been shown to be effective against most of our western bark beetles. However, with some exceptions, tree injections using emamectin benzoate may be effective against western pine beetle.

- **PESTICIDE PRECAUTIONS**
  Pesticides used improperly can be injurious to humans, animals, and plants. Follow directions and read all precautions on the label. Consult your local county agriculture agent or State extension agent about restrictions and registered uses of particular pesticides.

What is a Bark Beetle?

FEEDING LARVAE GIRDLING TREE

Bark beetles are small (≤1/4-inch long), hard bodied beetles that bore through the tree's protective outer bark to lay their eggs in the living tissue underneath. Following adult egg-laying, the developing larvae feed on this living tissue, further disrupting nutrient and water flow within the tree. Egg-laying and feeding galleries created by adult beetles and their larvae are unique for each species of beetle. Note that all bark beetle species described in this brochure are native insects.

MOUNTAIN (AND JEFFREY) PINE BEETLES

Mountain pine beetle attacks most native and introduced pine species, except Jeffrey pine which is attacked by the very similar Jeffrey pine beetle. Occasionally spruce are attacked, especially when mixed in a stand of host pines. Periodic mountain pine beetle outbreaks kill millions of pine trees throughout forests of western North America, making it one of the West's most important bark beetles.

MOUNTAIN PINE BEETLE GALLERIES

Beetle populations can reach outbreak proportions on susceptible landscapes during prolonged periods of drought. Trees as small as 4-5 inches in diameter may be attacked and killed during outbreaks, although few to no adult beetles are produced. In times of low populations, attacks are confined to trees stressed from overcrowding, disease, defoliation, injury or old age. Downed hosts trees are rarely attacked by this insect.

Successfully attacked trees can have faded foliage as early as 4-5 months following infestation, but generally fade 8-10 months following attack. Emerging adult beetles often begin dispersing in late June to mid-July with adult flight continuing into September. However, these dates may vary depend on elevation, latitude, and local weather.

Adult beetles are brown to black in color and about 1/4 inch long with a rounded rear end. The larvae are yellowish white, legless grubs with black heads found within feeding tunnels under the outer bark. The egg-laying gallery created by the female adult beetle is straight and vertical on the tree bole. Gallery length can be 3 feet or more. At the bottom of the gallery is a distinctive "J" shaped crook. Eggs are laid alternately along the walls of the egg laying gallery.

DOUGLAS-FIR BEETLE

The only host for this bark beetle is Douglas-fir. Outbreaks are often associated with trees that are windthrown, fire scorched or defoliated. Unlike mountain pine beetle, outbreaks are generally confined to smaller areas with tree mortality generally ranging from a few to several hundred trees. Outbreaks are also often of shorter duration.

Although the beetle prefers larger host trees, it will attack and kill trees of many sizes. Trees <8 inches in diameter, however, are more commonly attacked by Douglas-fir pole beetle. Dense stands of susceptible hosts spread over large landscapes can result in widespread mortality.

DOUGLAS-FIR BEETLE GALLERIES

Adult dispersal can occur from April through August depending on the site. Approximately 10 months after a successful mass attack, the tree's needles begin to turn yellowish-green. During drought periods, fading can occur within 4-5 months.

Adults are brown to black and about 1/4 inch long with a rounded back end. Larvae are whitish, legless grubs with brown heads found in the galleries under the bark. The egg-laying gallery is usually about 8-10 inches long with a small angled "J" at the bottom portion of the gallery. The female lays several eggs along one side of the egg gallery before alternating to the opposite side of the gallery to lay several more, repeating the pattern several times.

SPRUCE BEETLE

This bark beetle prefers Engelmann spruce, but will attack blue spruce when populations reach outbreak levels. Even during outbreaks, most blue spruce will survive. Outbreaks typically begin in areas of windthrown trees, with adult beetles dispersing to adjacent standing trees.

SPRUCE BEETLE GALLERIES

Widespread tree mortality can occur in Engelmann spruce dominated landscapes. Infested trees fade (needles turn a yellowish-green) approximately one year following mass attacks.

Spruce beetle can have a one or two-year life cycle. Adult beetles are 1/4-inch long, with reddish-brown or black wing covers. Larvae are yellowish white, legless grubs found under the outer bark. Spruce beetle egg galleries average 6-8 inches in length. Eggs are laid alternately along the gallery with larvae feeding gregariously outward in all directions.

WESTERN PINE BEETLE

Although in the same group as the previous beetles, this native bark beetle tends to be less aggressive, generally attacking individual large, overmature ponderosa pines. Often these trees have been hit by lightning, have root disease, suffer from drought, or are otherwise stressed. However, they can cause patches of mortality in dense stands of medium-sized trees. During periods of prolonged drought, insect population can reach outbreak levels. Note that this beetle is not found east of the Continental Divide.

WESTERN PINE BEETLE SERPENTINE EGG GALLERIES

Adult beetles are dark brown to black and slightly smaller than some of the other bark beetles, ranging from about 1/8-1/5 inch long. Adults create a distinctive random serpentine egg gallery pattern under the bark. Larval galleries are rarely seen since larvae inhabit the thick, corky outer bark during most of the year.

This bark beetle species can produce two generations per year depending upon weather conditions. Beetles begin attacks in late spring, continuing until colder weather inhibits further development and spread. Trees attacked in early summer may fade before adult beetles emerge in the fall. Trees attacked in September by the second generation of beetles, usually fade the following spring.

PINYON IPS

Most native bark beetles in the "ips" group are not aggressive tree killers. Rather, they tend to attack recently dead, damaged, or stressed trees. Pinyon pine trees, however, are often found in areas prone to water and heat stress. During drought periods, adult beetles overwhelm weakened trees 3 inches in diameter and larger. Outbreaks can affect large landscapes of susceptible hosts.

Adult beetle attacks begin early in the spring and can continue through early fall. Two or more generations are produced annually. Because of multiple generations, the insect can spread rapidly when conditions are favorable.

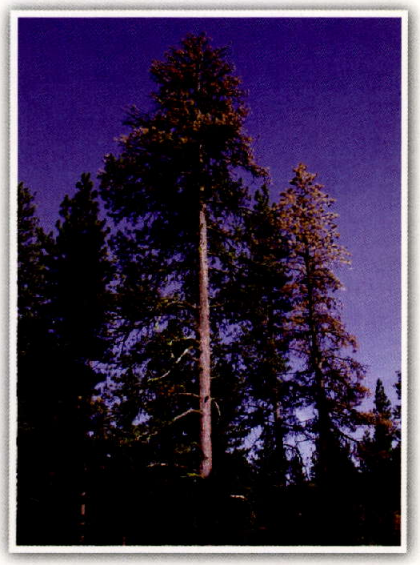
Pinyon ips are about 1/8-inch long, with an indented backside (versus a rounded back end) and small spines that are typical of all *Ips* species. Gallery patterns of most ips are similar, often a Y- or H-shape, with a larger mating chamber from which the separate egg galleries radiate. Larva and beetles overwinter under the bark where they consume large patches of inner bark. Wood borers often infest trees after pinyon ips attacks.

TYPICAL IPS GALLERY

PINE ENGRAVER BEETLE AND OTHER IPS SPECIES

Pine engraver (ips group) is most problematic in ponderosa and Jeffrey pine, although almost any pine species can be a host. Stress due to drought, fire, or other damage increases a tree's susceptibly to attack. However, recently cut logs (slash) or wind-thrown trees are preferred. If not properly managed, population levels can build in fresh slash or downed material in the spring. This preferred habitat can create localized outbreaks, killing patches of standing smaller diameter sized trees or topkill on large diameter hosts.

Pine engraver beetle adults are about 1/8-inch long, with an spiney, indented backside. The adults produce they typical Y- or H-shaped galleries. Beetles usually overwinter in the duff layer but may overwinter in previously attacked logs or trees. Once spring temperatures reach 65°F, beetles begin to fly until cold fall weather stops dispersal.



TOP-KILL OF A LARGE PONDEROSA PINE BY PINE ENGRAVER

Ponderosa pine is also a preferred host for several other ips beetles. The Arizona fivespined ips, found in southern Utah and the southeast portion of Nevada, can be fairly aggressive, attacking large trees over a wide area when drought conditions develop. The emarginated ips and sixspined ips, both larger engravers about 1/4-inch long, have caused tree mortality during drought years in eastern Montana. Many other species of ips attack pines and spruce. Ips species can be identified by the number and shape of spines on their backsides, and their typical Y- or H-shaped galleries containing little frass. Wood borers often infest trees following ips attacks.

H-SHAPED GALLERY TYPICAL OF IPS

FIR ENGRAVER

This species attacks true firs (less often subalpine fir); Douglas-fir is not a true fir. The insect causes topkill, branch kill and tree mortality, attacking trees >3 inches in diameter. Tree needles generally turn yellow-red within 3-5 months. Evidence of attack before trees fade is often hard to detect; entrance holes are without pitch tubes and in the Intermountain West, pitch streamers may or may not be present. Boring dust in bark crevices and around the base of tree or fading needles are more reliable signs of successful attacks.

FIR ENGRAVER GALLERIES

Adult beetles are about 1/8-inch long, black, with a truncated, spineless back end. The egg galleries run horizontally across the stem, averaging 6 inches in length. Larvae mines radiate vertically out from the egg gallery. Following attack, a fungus associated with the beetle stains the surrounding attacked area a yellow-brown color. Larvae overwinter under the outer bark with adult beetles emerging in June. Adult flight may occur from June-September. The life cycle is usually one year.

WESTERN BALSAM BARK BEETLE

This species is associated with bark beetle attacks on subalpine fir. Adults are about 1/8 inch long, and brown or black in color. There is a distinctive hairy patch (toupee-like) on the head of the female beetle. The gallery pattern is star shaped.

External evidence of successful attacks by western balsam bark beetle is often difficult to detect. Entrance holes are often high on the trunk, but boring dust may be visible in bark crevices in late summer. Pitch flow may also be observed with fine boring dust present in the pitch if attacks were successful. Needles on successfully attacked trees turn yellowish-red within a year and can remain bright red for several years after death. Outbreaks of this insect are often initiated by prolonged drought and windthrow.

WESTERN BALSAM BARK BEETLE AND GALLERIES

Generally a two-year life cycle is observed, but one-year life cycles are also possible. Two peak flights of adult beetles occur, late June/early July and late July/early August.

CHALLENGES OF A BARK BEETLE OUTBREAK- WHAT ARE LAND MANAGERS DOING?

FEDERAL AND STATE LAND MANAGERS

Developing management strategies to mitigate bark beetle effects is a difficult challenge for Federal and State resource managers. Forest health specialists understand tree and stand characteristics that increase susceptibility for many of the bark beetle species discussed in this brochure and, in conjunction with resource managers, develop silvicultural treatments to reduce impacts caused by these insects. Regardless of the treatment bark beetle outbreaks are not preventable; only their impacts can be reduced.

Land management planning is required for all Federal and State administered lands. Public involvement is invited and encouraged as part of the Federal planning efforts. Some areas on Federal lands are excluded or restricted from vegetation management activities (i.e. wilderness and roadless areas). Resource tools to manage bark beetle populations within these areas are often not available.

Where vegetation management treatments are permitted, Federal and State resource managers can develop treatments to reduce stand densities, increase tree species and age diversity, and remove bark beetle-infested trees.

Often resource managers develop treatments to reduce bark beetle impacts within the treated landscapes. Removing infested trees as a stand-alone treatment may help suppress developing populations of bark beetles. But, if adjacent stands contain beetle populations and the treated sites remain susceptible, bark beetles may reinfest the treated area. Protection of individual, high-value trees can be accomplished with insecticide and pheromone treatments.

PRIVATE LANDOWNERS

Treatments developed for private lands will vary depending on the objectives of individual owners. Some may choose to do nothing and let nature take its course; others may prefer a more aggressive approach and initiate treatment strategies similar to those described for Federal and State land managers.

Land owners who do no treatment and choose to leave infested trees or stands susceptible to bark beetles could affect residual trees on adjacent ownerships where treatments have occurred. Mixed ownerships in close proximity to one another with various objectives complicate developing effective treatment strategies. A number of factors can affect this decision process including: treatment options may not be available to all ownerships, treatment economics may effect implementation and site conditions may be too difficult to treat (eg. steep slopes).

Fortunately, there are effective single-tree treatments available for high-value trees. Repellent pheromones and preventative insecticides are treatment options available to private landowners. These single tree or small area treatments will require continuous applications until bark beetle populations collapse.

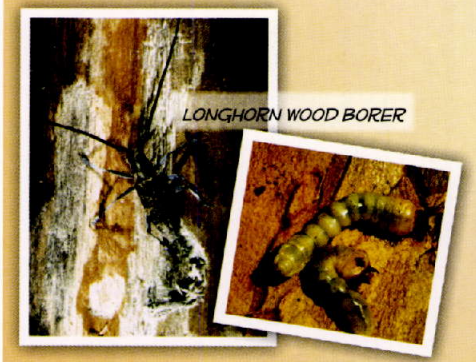
OTHER AGENTS . . .
THAT CAUSE DAMAGE SIMILAR TO THAT OF BARK BEETLES

Other insects or animals can cause damage to trees that may resemble bark beetle activity. We have listed a few of these to help you discern between bark beetle attacks and activity from other agents.

Bark beetles have often left their host tree by the time you see red needles. Inspection of the dead tree may reveal insects that were not directly responsible for the tree's death.

A BARK BEETLE (LEFT) AND METALIC WOOD BORER (RIGHT)

Most often confused with bark beetles are the metallic and longhorn **WOOD BORERS**. Wood borers are much larger than bark beetles. These borers feed on the phloem just as bark beetles do; however, their galleries lack a distinct shape. While developing, the larva may drill large oval or round holes into the wood. Depending on the species, their life cycle may take from one to over ten years to complete.



LONGHORN WOOD BORER

METALLIC WOOD BORER

AMBROSIA BEETLES are very small, creating multiple pin holes in wood where they cultivate a fungi (ambrosia) that they feed on.

WOOD WASP larva make large holes in dead wood similar to wood borers but the larva do not feed in the phloem.

Even woodpeckers (**SAPSUCKERS**) can make holes in the bark that may look like bark beetle entrance/exit holes.

DEFOLIATING INSECTS

Other insects and diseases can cause damage to the needles of trees that may look like bark beetle activity from a distance.

LANDSCAPE DAMAGE

Western spruce budworm (Choristoneura occidentalis Freeman) (WSBW) and Douglas-fir tussock moth (DFTM) (Orgyia pseudotsugata (McDunnough)) are two of our most conspicuous foliage feeding insects. Larvae of both of these moths feed on Douglas-fir, all true firs, and spruce (also larch for western spruce budworm).

WSBW LARVAE HAVE PAIRED WHITE SPOTS ON BOTH SIDES OF EACH BODY SEGMENT

OLDER DFTM LARVA WITH "TUSSOCKS" AND "HORNS"

Although feeding larvae prefer new needles, older needles are often consumed during outbreaks. Trees often appear reddish-orange in color as partially consumed needles fade. Branch tips will be bare and often covered with silk webbing and dead needles.

TREE CROWN DAMAGE FROM FEEDING LARVAE

Contact your local State forest health specialist for assistance with identification and suppression treatments of defoliators.

WHERE TO GO FOR HELP OR ADDITIONAL INFORMATION

ORGANIZATIONS

- For on-the-ground technical assistance with insect and forest management on private lands:
  - In Idaho, contact Tom Eckberg, Idaho Department of Lands, (208) 666-8624, techberg@idl.idaho.gov, (http://www.idl.idaho.gov/Bureau/forasst.htm.)
  - In Montana, contact Amy Gannon, Montana Department of Natural Resources, (406) 542-4283, agannon@mt.gov, (http://dnrc.mt.gov/forestry/assistance/pests/default.asp)
  - In Nevada, contact Gail Durham, Nevada Division of Forestry, (775) 684-2513 or 687-0431, gdurham@forestry.nv.gov, http://forestry.nv.gov/?page_id=241
  - In North Dakota, contact Aaron Bergdahl, North Dakota Forest Service, http://www.ndsu.nodak.edu/forestservice/stateforest/state_forest_home.htm
  - In Utah, contact Colleen Keyes, Department of Natural Resources Division of Forestry, Fire, and State Lands, (801) 538-5211, ColleenKeyes@utah.gov, http://utahpests.usu.edu/
  - In Wyoming, contact Les Koch, Wyoming State Forestry Division, (307) 777-5495, lkoch@state.wy.us, http://slf-web.state.wy.us/forestry/health2.aspx
- For information on professional pesticide applicators and insecticide registration contact your local state Department of Agriculture, division of pesticide licensing. Web pages to assist you with the contacts are listed below:
  - Idaho: http://www.agri.idaho.gov (see noxious weed contacts)
  - Montana: http://www.agr.state.mt.us/ (see pesticides, program contacts)
  - Nevada: http://agri.nv.gov/index_Plant2.htm or http://agri.nv.gov/PLANT_Chemistry_Index.htm
  - North Dakota: http://www.agdepartment.com/Programs/Plant/Pesticides.html (see laws and regulations for contacts)
  - Utah: http://ag.utah.gov/
  - Wyoming: http://wyagric.state.wy.us/divisions/techserv/sections/pesticide.htm
- For general National Forest information, contact the National Forest directly
- For information on USDA FS Forest Health Protection for the Northern and Intermountain Region, visit http://www.fs.fed.us/r1-r4/spf/fhp/index.html
- Visit the FIREWISE™ program at www.firewise.org
- Additional pictures of the various trees and insects mentioned in this pamphlet can be found at www.bugwood.com

PUBLICATIONS

- A Field Guide to Diseases and Insect Pests of Northern & Central Rocky Mountain Conifers (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/index.htm)
- Forest Insect and Disease Management Guide (http://www.fs.fed.us/r1-r4/spf/fhp/mgt_guide/index.htm)
- Forest Insect and Disease Leaflets (FIDLs) for a variety of forest pests (http://www.na.fs.fed.us/spfo/pubs/fidl.htm)
- Using MCH to protect trees and stands from Douglas-fir beetle infestation (http://www.fs.fed.us/r1-r4/spf/fhp/publications/MCH_brochure/MCH_online.pdf)
- This pamphlet is also available on-line (http://www.na.fs.fed.us/r1-r4/spf/fhp/index.htm.html)

THE ROLE OF FIRE

Trees with red needles are more flammable than live trees. However, once the needles have fallen, standing dead trees no longer increase wildfire risk. As the trees drop to the ground, the addition of downed woody fuels does increase fire intensity and severity.

Fire is a natural part of the ecosystem. Vegetation in the West has evolved in fire driven ecosystems and in many cases relies on fire for sustainability and forest health.

However, wildfires around human habitation are often not desirable. Research indicates that the most critical factors to mitigate fire loss around structures are the construction materials used, and the type and distance of vegetation around the structure.

FIREWISE™ is a multi-agency, nonprofit program designed to assist individuals with wildfire survivability to reduce structure losses. The program encourages developing a "defensible space" around your home. Information on how to reduce losses to wildfire can be found on a variety of **FIREWISE™** websites.

General recommendations to reduce structure losses include:

1. Roofs should be constructed of nonflammable material.
2. Enclose places on structures where fire embers can accumulate.
3. Thin dense vegetation around the home.
4. Remove brush or dried grasses adjacent to the home.
5. Landscape with fire resistant plants.
6. Keep firewood and propane tanks at a safe distance from the home.

Firefighter safety is a primary consideration in any fire incident. Creating "defensible space" will enhance opportunities for firefighters to safely protect your home.

For additional information on measures to protect your home, visit the FIREWISE™ website (www.firewise.org) or contact your local fire department.

06/09