

MAJOR BARK BEETLES OF THE INTERMOUNTAIN WEST

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Forest conditions are declining throughout much of the Intermountain West. Decades of fire exclusion have caused forest overstocking, layering, and encroachment by shade tolerant climax tree species. During drought, forests in decline are especially attractive to bark beetles along with other insect pests.

Bark beetles once served a natural beneficial role. Now, in the Intermountain West, bark beetles are thought of as a pest killing trees across millions of acres of fire-excluded forests no longer in balance with climate and soil conditions. More forests will become susceptible to bark beetles without dedicated efforts to alter and improve forest condition. Forest condition is the problem, not bark beetles.

Historically, slow moving ground fires periodically thinned forests and crown fires consumed patches of old dense timber. These natural fires renewed the forest creating a diverse mosaic-like forest landscape of mixed size and age classes less vulnerable to bark beetles. Beetle killed trees now contribute to an abundance of both ground fuel and ladder fuel increasing the risk of dangerous, costly to control wildfires in already fire-vulnerable forests. This process is natural, but unacceptably out-of-balance with historic conditions.

Bark beetle populations fluctuate year-to-year depending on the prevalence of stress-causing conditions in the forest. During “normal” years, beetle populations tend to decline because reasonably healthy trees are better able to resist beetle attacks. During drought years, beetle populations tend to increase. Bark beetle outbreaks may last for several years depending on weather and forest condition.

Individual trees or forest stands are stressed and weakened by many causes. From a landscape perspective, drought and overstocking are the primary predisposing factors making forests vulnerable to beetle outbreaks. Other predisposing factors include:

- Infections by root disease and dwarf mistletoe
- Defoliation by other insect pests
- Windthrow
- Snow and ice damage
- Fire scorch
- Poor growing conditions
- Trunk and root injury during logging
- Soil compaction
- Fresh logging slash available in spring and early summer
- Thinning shock

Basic Bark Beetle Biology

Bark beetles only infest living trees or damaged and down trees that are still “green”. When the live inner bark and outer layer of sapwood have dried, the tree no longer provides good bark beetle food and habitat. At “normal” population levels and under “normal” conditions, bark beetles can only successfully attack trees suffering moisture stress induced by disease or damage. Beetles preferentially seek out moisture stressed trees because they produce less resin. Healthy trees easily repel beetles with an abundance of resin flooding entrance holes and galleries.

Beetle populations build up in weakened, drought stressed stands potentially becoming an outbreak. Once beetles find a suitable host tree, they release aggregating pheromones to attract other beetles enabling a “mass attack” that can overwhelm even a healthy tree’s defenses. Along with releasing pheromones, the attacking beetles introduce a staining fungus that infects and blocks the sapwood further weakening the tree. Aggregating pheromones plus a pathogenic fungus infection help make relatively healthy trees a quick meal for bark beetles.

Blue Stain Fungus

Bark beetles don’t work alone when attacking trees. Beetles carry the spores of blue stain fungus. The spores are introduced to the tree in the galleries excavated by the attacking beetles. The fungus infects and quickly grows in the sapwood blocking the movement of water and nutrients. Trees weakened by blue stain offer little resistance to attacking bark beetles. Resin flow slows and the beetles overcome the tree. After a few months, the sapwood becomes blue to almost black.



(Forestry Images 1441012)

Bark beetles develop through 4 life stages: egg, larva, pupa, and adult. Most of the major bark beetle species have one generation per year. Some species have multiple generations in a single year and others need two years to complete a generation. The life cycle accelerates when temperatures are unusually warm and slows when temperatures are cool.

Beetles spend almost their entire life beneath tree bark. After mating, an “egg gallery” is excavated by the female beetle, sometimes with help from a male friend. Eggs, laid along the sides of the gallery, hatch within a few weeks. The larvae feed on the nutritious inner bark of the tree, pupate, and then emerge as an adult. The adult beetle only spends a few days outside the bark flying to locate a new host.

Each bark beetle species has preferred tree hosts, and usually a preferred size of host and location of attack. Bark beetle attacks often leave plainly visible evidence such as pitch tubes, resin streams, boring dust, and egg galleries. Foliage

fades to yellowish-green and then to reddish-brown within a few months or the following year.

Most bark beetles look the same to the casual observer. Bark beetles are usually less than ¼ inch long, shiny brown to black, cylindrical, with hard wing covers. Basically, they look like everyday beetles, only smaller. Fortunately, unique, easily observed egg gallery patterns distinguish the major beetles.



An adult spruce beetle in its egg gallery. Note the tiny white eggs along the gallery wall. All bark beetles have a similar appearance, but are microscopically different.

(Forestry Images 1678051)

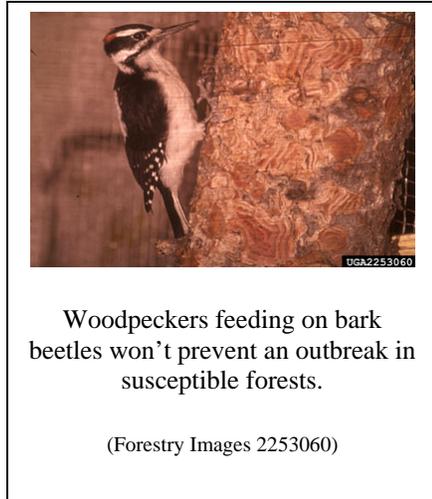
Bark beetles excavate egg galleries like tiny tunnels in the live inner bark. Engraver beetles score the sapwood, too. Larvae excavate “larval mines”. Bark beetle galleries weaken the host tree and eventually kill it by girdling. Water and nutrient transport in the live inner bark and in the outer edge of the sapwood are effectively disrupted. Look for egg galleries and larval mines by peeling away the bark of recently killed trees.



Bark beetle larvae feed on nutritious live inner bark in “larval mines”.

(Forestry Images 2252077)

Normal populations of bark beetles are kept in check by woodpeckers and other insect eating birds, parasitic wasps, and predatory beetles. Woodpeckers often chip away outer bark to expose larvae and adult beetles. Natural controlling agents won't prevent an outbreak of bark beetles in susceptible forests.



Ecological Role

Bark beetles and forests evolved together in the Intermountain West. In balanced forests, beetles have many beneficial roles:

- Beetles “thin” naturally overstocked forests. Beetle-induced thinning is often irregular and patchy contributing to forest diversity. Gaps encourage changes in vegetation and forest structure beneficial to wildlife.
- Beetle killed trees are a food source important to birds and other insect predators. Snags provide roosting and nesting habitat.
- Beetles help recycle old forests. Beetles introduce wood decay fungi through the bark where adults burrow into trees. Decay fungi help to rapidly decompose wood and hasten nutrient recycling back into the soil.
- Normal populations of bark beetles and associated decay organisms help keep forest fuel loads low.
- Beetle outbreaks help build fuels necessary for stand replacement fires in patches of overstocked and decadent timber.

Basic Forest Management to Improve Resistance to Bark Beetles

Fire is Nature's way of fixing unacceptable forest conditions. Overstocked, beetle vulnerable forests will eventually be replaced by fire. Alternatively, out-of-balance forests can be thinned to renew tree and stand vigor or harvested, with consideration for watershed issues and wildlife habitat needs, to reduce fuel loading.

Carefully planned forest thinning and harvesting will yield long-term improvement of forest health. Vigorous stands across diverse forest landscapes are less susceptible to insect attack and destructive wildfire. Also, properly stocked forests are much more suitable for the re-introduction of safer, controlled prescribed fires that mimic natural fires. Prescribed fires can help control fuel loading, forest stocking, composition, and diseases thereby reducing susceptibility to bark beetles.

Basic strategies to minimize losses to bark beetles include:

- Maintain healthy, vigorous, fast growing trees by thinning overstocked stands. Thinning allocates available moisture and nutrients to fewer trees thereby improving overall tree and stand vigor. Thinning reduces fire hazard, too. Preferentially remove slow growing, damaged, or diseased trees saving the most vigorous trees appropriately spaced for site conditions.
- Avoid creating logging and thinning slash from early winter through mid-summer. Fresh slash is breeding habitat for several bark beetle species.
- Encourage a diversity of site-adapted species where possible. Mixed species stands are much more resistant to insect pests and diseases than single species stands. Patches of different age trees further diversify forest landscapes improving beetle resistance.
- Minimize tree injury and soil compaction during thinning and harvesting. Carefully planned designated skidtrails help limit soil damage.
- Do not bring home firewood from beetle-infested trees especially when foliage is fading. Wood cut at this time harbors beetles that may attack trees at your home. Following beetle emergence, wood can be used without threat to your trees. Simply the aroma of fresh pine firewood may attract pine bark beetles.

Red Turpentine Beetle

The hosts are ponderosa pine, western white pine, lodgepole pine, and sugar pine. Beetles attack the lower trunk of weakened or stressed pole-size and larger pines, usually below 4 feet. Red turpentine beetle attacks are rarely lethal, but may predispose the host tree to attack by more aggressive western pine beetle or mountain pine beetle.

Look for...

- Conspicuous globular reddish pitch masses about 1 inch across on the lower trunk.
- Irregular cave-like egg galleries. Larvae enlarge the egg gallery forming a vertical cavity about 1 inch wide and about 12 inches long.

Special Recommendations and Concerns:

- Opens wounds caused by pruning live branches may attract red turpentine beetles.



Red pitch masses near the base of a ponderosa pine indicate attack by red turpentine beetles. Infested trees typically survive unless attacked by more aggressive bark beetles.

(Forestry Images 2254026)

Pine Engraver Beetle

The hosts are ponderosa pine, lodgepole pine, and western white pine. Saplings and pole-size trees 5 to 8 inches in diameter are most commonly attacked and killed. Tops of larger trees are attacked, too.

Look for...

- Reddish-brown boring dust in bark crevices on standing trees.
- Tiny mounds of boring dust on the surface of small logs.
- Pitch tubes seldom formed.
- “Radiate” egg gallery with several branches aligned with the grain of the wood. Branches 2 to 6 inches long extend from a central chamber.
- Thickets of small dead pine displaying reddish-brown foliage.

Outbreaks are usually associated with spring and early summer drought. Overstocked stands of sapling and pole-size pine are especially attractive to beetles. Usually, attacks are of short duration. During droughts, damage may continue for 2 to 3 years. In most years, when populations are low, pine engraver beetles may kill or top-kill widely scattered single trees or small groups. In outbreak years, engraver beetles kill large groups of trees, especially in unthinned young stands.

As beetles become active in the spring, they infest fresh logging or thinning slash and weak or damaged trees. Beetle populations build up in fresh slash with subsequent generations attacking and killing live trees. Stands of juvenile pine thinned in the spring are especially vulnerable. Slash created in late summer and fall will usually dry sufficiently to be unsuitable for pine engravers by the following spring.

Special Recommendations and Concerns:

- Avoid creating green slash with diameters greater than 3 inches from early winter through mid-summer.
- Lop and scatter slash created in the spring to facilitate fast drying.



Boring dust around entrance holes created by pine engraver beetles on pine slash. Removing bark will reveal galleries.

(FIDL 122)



Pine engraver beetle galleries “engrave” the sapwood. Female beetles create a “radiate” egg gallery with legs extending from a central chamber. Radiate galleries are typical for polygamous beetle species.

(SWOFIDSC)



Crowded, small diameter ponderosa pine killed by pine engraver beetles. Thinning in late summer or early fall would have helped prevent this attack.

(FIDL 122)



Pine engraver beetles breed in slash favoring pieces smaller than 8 inches across. Slash created during early winter through mid-summer may attract pine engraver beetles.

(Forestry Images 2252071)

Western Pine Beetle

Ponderosa pine is the host. Beetles prefer trees larger than 10 inches in diameter attacking the largest part of the trunk. Usually, western pine beetles breed in and kill scattered, overmature, slow-growing, decadent trees. Group killing of trees is common in overstocked stands of sawlog-size timber.

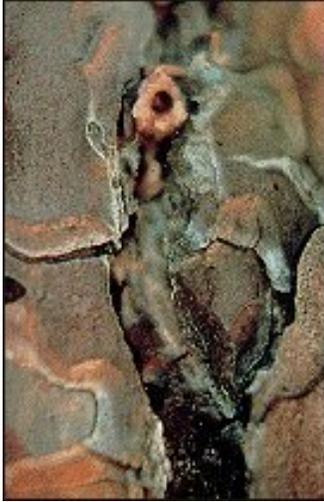
Look for...

- Reddish-brown boring dust in bark crevices on standing trees.
- Inconspicuous pink to reddish brown pitch tubes.
- Winding crisscrossing egg galleries in the live inner bark.
- Scattered dead large ponderosa pine or mature trees killed in clumps.
- Infested trees “debarked” by woodpeckers searching for beetle larvae.

Healthy trees weakened by drought are especially attractive to western pine beetle. During drought, beetles breed and develop in the thick nutritious live inner bark of an otherwise healthy tree without suffering from an abundant resin flow. Generally, trees that are not under water stress can fend off an attack when beetle populations are at normal levels. Diseased or crowded trees are easily killed, but the thin inner bark layer is poor beetle habitat and produces few beetles.

Special Recommendations and Concerns:

- Large, old, picturesque ponderosa pines are commonly attacked.
- Thin clumps of large old pine only if root disease is not present.
- In some situations, watering and applying potassium fertilizer may help protect old trees.



Tiny pitch tubes indicate an attack by western pine beetle. Pitch tubes are not always present. Look for fading foliage and bark stripping.

(FIDL 1)



Winding crisscrossing gallery pattern identifies the presence of western pine beetle. Look for galleries under the bark of dead large pine.

(Forestry Images 1678047)



Woodpeckers strip bark looking for beetle larvae—a clear indication of western pine beetle attack. Note the dense pine stand in the background. These smaller trees are susceptible to attack by mountain pine beetles and pine engraver beetles.

(Forestry Images 2253078)

Mountain Pine Beetle

The hosts are lodgepole pine, ponderosa pine, western white pine, and sugar pine. Beetle attacks usually occur in the middle of the trunk and lower. Mountain pine beetle is the most damaging bark beetle in the Intermountain West.

Outbreaks of mountain pine beetle typically begin in weakened, stressed trees. The outbreak then spreads to healthy timber as the beetle population slowly increases. Outbreaks may last several years killing large numbers of trees across thousands of acres of susceptible forest. Dead trees left after epidemics are a source of fuel that will burn unless removed.

Look for...

- Reddish-brown boring dust in bark crevices on standing trees.
- Obvious, pink to reddish brown pitch tubes.
- Vertical egg galleries usually 1 to 3 feet long with a crook on the bottom end.
- Small, round, pitch-free exit holes chewed through the bark by exiting beetles.
- Clumps and patches of dead small sawlog-size trees usually 8 to 14 inches in diameter.

Mountain pine beetles prefer trees with diameters greater than 10 inches and older than 80 years for breeding habitat. Trees from 4 to 5 inches in diameter and up may be attacked and killed, but larger trees with thick live inner bark are required for an outbreak population to develop. After the larger pines are killed, beetles infest smaller trees and the outbreak population begins to decline.

Special Recommendations and Concerns:

- Thinning to maintain and enhance tree vigor is essential for preventing mountain pine beetle outbreaks. High elevation lodgepole pine forests may suffer thousands of acres of mortality followed by expensive-to-control wildfire if stand vigor is not maintained and mature trees harvested.
- Thinning or logging slash created in early winter or spring may invite pine engraver beetles.



Long, straight mountain pine beetle egg galleries tunneled beneath the bark of ponderosa pine. Note the “J” shaped crook at the bottom of the gallery.

(Forestry Images 3227025)



“Pitch tubes”—a defensive response by the tree trying to expel attacking mountain pine beetles. Pitch tubes are a mix of resin and boring dust.

(Forestry Images 2252082)



Thinning pine improves stand vigor and resistance to mountain pine beetle attack.

(Forestry Images 1441154)



Mountain pine beetle attacks can quickly increase dead fuel loading and wildfire hazard across a landscape.

(Forestry Images 1441150)



Ponderosa pine killed by mountain pine beetle. Overstocked, small sawlog-size timber is especially attractive to mountain pine beetle.

(SWOFIDSC)

Fir Engraver Beetle

True firs are the host, primarily grand fir, white fir and red fir. Fir engravers attack the trunk often near branch collars, usually in areas greater than 4 inches in diameter.

Fir engraver beetles are secondary pests. They cannot successfully attack and kill healthy vigorous trees. On weakened trees, beetles cause branch-flagging, topkill, or the entire tree may be killed in a single summer.

Look for...

- White to reddish-brown boring dust in bark crevices on standing trees.
- Pitch tubes are not formed.
- Streams of clear resin exuding from entrance holes.
- Horizontal egg galleries lightly engraving the sapwood.
- Individual beetle-killed branches or “flagging”.
- Clumps of engraver beetle killed fir often indicate root disease pockets.

Fir engraver beetles infest and breed in weakened pole-size and larger trees. Vigorous firs may exude enough pitch to drown the beetles or cause them to abandon attack. Breeding also occurs in fresh logging slash larger than 4 inches across and recently windthrown trees.

Special Recommendations and Concerns:

- Remove diseased, injured or decadent trees that provide breeding habitat.
- Remove windthrown trees and cut logs within the year.
- Decrease stocking by grand fir.
- Avoid creating large pieces of true fir slash from early winter through mid-summer.
- Fir engraver attacks are commonly associated with root disease. Logging on root disease centers may accelerate root disease spread.
- Save soft snags and snag recruitment trees for beneficial wildlife habitat.



Horizontal egg gallery 3 to 12 inches long identifies fir engraver beetles. Note the “engraved” sapwood and the subtle gull-wing pattern with central entrance chamber. Larval mines extend vertically.

(SWOFIDSC)



Low hanging branches become hazardous “ladder fuel” on grand fir killed by fir engraver beetles.

(Forestry Images 0806067)



Fir engraver beetles sometimes only kill the top of a tree.

(SWOFIDSC)

Douglas Fir Beetle

Douglas fir is the host. Attacks by Douglas fir beetle are usually most abundant about mid-trunk, but seldom higher than a top diameter of about 8 inches. Douglas fir beetles normally kill small groups of trees. During outbreaks, extensive mortality including healthy trees is possible. Outbreaks in standing trees range from 2 to 4 years with the longest outbreaks occurring during droughts.

Look for...

- Reddish-brown boring dust in bark crevices on standing trees.
- Tiny mounds of boring dust on windthrown trees.
- Pitch tubes are not formed.
- Streams of resin exuding from entrance holes.
- Straight, parallel to the stem, egg galleries commonly 10 to 20 inches long. Larval galleries fan out from alternate sides.
- Clumps and patches of dead mature trees.

Normal low beetle populations infest scattered weakened trees and windfall. Generally, beetle's reproduce most successfully in down trees. Outbreaks occur when large areas of forest are blown down or damaged by ice and snow providing abundant breeding habitat. Forests weakened by drought or suffering from infestations by defoliating insects are highly susceptible, too. During outbreaks, healthy trees may be killed. Beetle attacks are most successful on large older trees, especially in densely stocked stands.

Special Recommendations and Concerns:

- Remove windthrown, damaged, and diseased trees within 1 year to prevent beetle population buildup.
- Harvest mature or overmature stands.
- Regenerate other species on root disease sites and discourage dwarf mistletoe.
- Large numbers of cull stems should not be left after logging, especially if they are shaded.



Douglas fir beetle egg galleries on a windthrown Douglas fir. Down trees usually have more galleries than attacked live trees.

(Forestry Images 1201026)



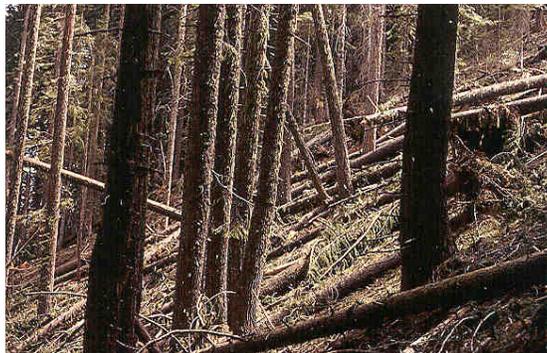
Douglas fir beetle boring dust marks entrance holes on windthrow.

(SWOFIDSC)



Mature Douglas fir killed by Douglas fir beetle.

(SWOFIDSC)



Blown-down Douglas fir provides ideal Douglas fir beetle habitat.

(SWOFIDSC)

Spruce Beetle

Engelmann spruce is the host. Spruce beetles prefer to attack the lower trunk of trees with diameters larger than 8 to 12 inches. Smaller trees are attacked during outbreaks. Outbreaks cause extensive tree mortality and increased wildfire risk.

Look for...

- Reddish-brown boring dust in bark crevices on standing trees.
- Resin exuding from entrance holes.
- Straight, vertical egg galleries usually 6 to 12 inches long, sometimes with a crook on the lower end. Larval mines extend horizontally from the egg gallery.
- Patches of dead trees usually with diameters greater than 12 inches.
- Infested trees “debarked” by woodpeckers searching for beetle larvae.

Normal spruce beetle populations usually live in scattered windthrown trees. Beetle populations build up in extensive windthrow, especially during droughts and successive warm summers. Early during an outbreak, beetles preferentially attack large standing trees with diameters greater than 18 inches. Dense stands with an abundance of large, weakened spruce trees are most susceptible. If an outbreak persists, smaller diameter trees are attacked.

Special Recommendations and Concerns:

- Cut stumps close to the surface to minimize beetle winter habitat.
- Limb cull logs and tops, cut into short lengths, and leave exposed to sun to speed drying.
- Shallow-rooted spruce may blow down easily where too widely spaced following thinning.



Spruce beetle egg galleries are straight and vertical. The lower end of the egg gallery may have a slight crook. Initially, larvae feed in a group creating a chamber before separating into individual mines extending horizontally.

(Forestry Images 0949045)



Pitch streams on Engelmann spruce indicating spruce beetle attack.

(USFS--R6)



Woodpeckers chip away the outer bark searching for spruce beetles and their larvae.

Forestry Images 0805010



Engelmann spruce killed by spruce beetles. Dead ladder fuels accelerate fire spread to the crowns encouraging stand replacement wildfires.

(USFS--R6)