THE MOUNTAIN PINE BEETLE

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Mountain Pine Beetles (MPB) are one of the most damaging insect pests of Wyoming's pine forests. The MPB has caused extensive damage to trees on mountains, and in urban or urban-interface areas all pines are susceptible. They have resulted in the loss of millions of trees annually. The problem exists Statewide in any forested area. MPB develop in all mature pine species, especially in ponderosa, lodgepole and limber pine.

Outbreaks of MPB develop regardless of property lines, being equally evident in wilderness areas, mountain subdivisions and urban back yards. Even windbreak or landscape pines many miles from the mountains can succumb to beetles imported in infested firewood.

During epidemics, widespread tree mortality alters the forest ecosystem. Beetles have almost totally depleted some commercial pine forests and, in some cases, have converted valuable forests to less desirable timber species such as subalpine fir. Sometimes, forested areas are reduced to grass and shrubs.

The profusion of beetle-killed trees can change wildlife composition and distribution by altering their habitat, hiding and thermal cover, and by impeding their movement. Moreover, the dead trees left after epidemics are a source of fuel accumulation that will, in time, burn unless removed.

Signs and Symptoms of MPB Attack

- Popcorn-shaped masses of resin, called "pitch tubes," on the tree trunk where the beetle began tunneling.
- Boring dust in bark crevices or on the ground immediately adjacent to the tree base.
- Evidence of woodpecker feeding on tree trunk. Patches

of bark are removed and bark flakes lie on the ground at the base of the tree.

- Foliage turning yellowish to reddish throughout the entire tree crown. This usually occurs eight to 10 months after a successful MPB attack.
- Presence of live MPB (eggs, larvae, pupae and/or adults) as well as egg galleries under the bark. This is the most certain indicator of infestation. Removal of bark with a hatchet is needed to check trees correctly.
- Blue stained sapwood. Check at more than one point around the tree's circumference.

Pitch Tubes and Boring Dust

Woodpecker Damage

MPB adult, eggs and larvae

Bluestained Sapwood

These symptoms are very similar to the Pine Engraver (*Ips*) beetle; be sure to properly identify the beetles you find on your tree.

Identification

Mountain pine beetles and related bark beetles in the genus *Dendroctonus* can be distinguished from other large bark beetles in pines by the shape of the hind wing cover. In side view, it is gradually curved (Figure 1). The wing cover of *Ips* or Pine Engraver beetle, another common group of bark beetles attacking conifers, is sharply spined (Figure 2).

Figure 1: Top view of adult MPB (actual size, 1/8 to 1/3 inch).

The most common hosts for adult MPB's include large ponderosa, lodgepole and limber pines. During early stages of an outbreak, the trees most likely to be attacked are limited largely to trees not growing vigorously due to stress from injury, drought, poor site or growing conditions, fire or mechanical damage,

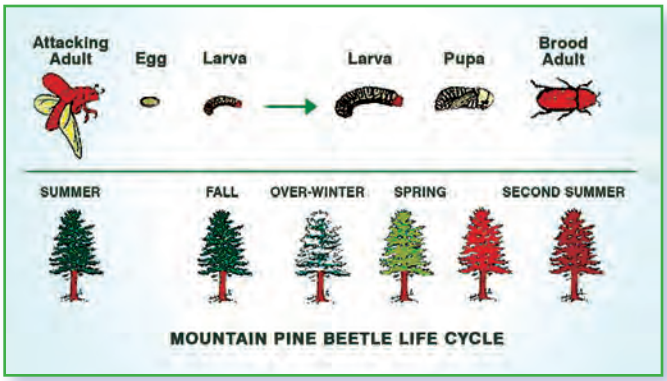
Figure 2: Adult *Dendroctonus* (left) versus *Ips* (right). Note gradually curved wing of *Dendroctonus*. Actual size of *Dendroctonus* from 1/8 to 1/3 inch, *Ips* 1/3 to 1/4 inch.

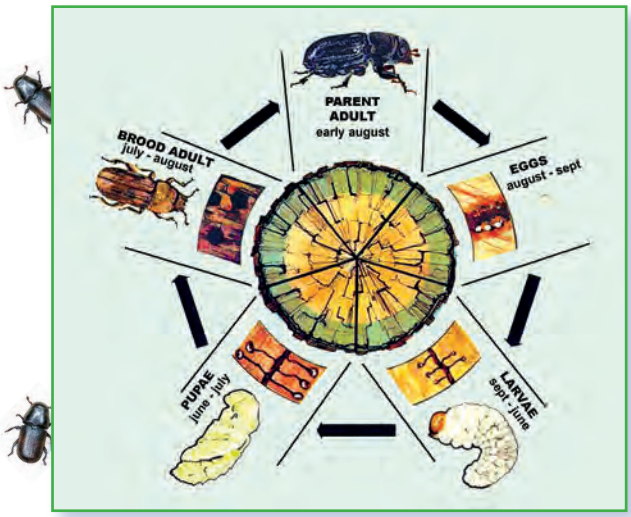
overcrowding, root disease or old age. However, as beetle populations increase, MPB attacks may involve most large trees in the outbreak area, healthy or not.

Life History and Habits

MPB has a one-year life cycle. In mid to late summer, adults leave the dead, yellow-to-red needled host trees in which they developed. Beginning in mid-July, adult MPB leave the trees in which they have developed to find new homes for the next generation. In general, females seek out larger diameter (over

5" diameter), live trees. However, under epidemic or outbreak conditions, small diameter trees may also be infested. Coordinated mass attacks by many beetles are common. MPB develops through four stages: egg, larva, pupa, and adult. Except for a few days during the summer when adults emerge and fly to new trees, all stages are spent under the bark of infested trees. The beetle usually takes one year to complete its life cycle.





Mountain Pine Beetle Life Cycle

Un-mated female beetles make the first attacks by tunneling under the bark and release chemicals called aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. Adjacent trees are then infested.

The beetles enter the tree by boring into the bark creating the familiar, identifiable pitch tubes, which is the tree trying to repel the attack by *pitching-out* the beetle. Boring dust will appear in the bark crevices and on the ground around the base of the tree.


Pitch Tubes and Boring Dust

Mating occurs under the bark, and female beetles construct straight, vertical tunnels (egg galleries). Packed with boring dust, these galleries are mostly in the phloem, or inner bark, although they slightly score the sapwood. They range from 4 to 48 inches long, averaging about 10 inches long.


Egg Galleries

Each female will produce about 75 tiny, pearl-white eggs in niches along the sides of the galleries, usually during late summer and early fall. After mating, the adult beetles die completing their life cycle. The eggs hatch in 10 to 14 days, although they may take longer during cool weather.

Following egg hatch, larvae broods (grubs) feed on the phloem, constructing galleries that extend at right angles to the egg galleries producing a characteristic feeding pattern. The legless larvae are white with brown heads. When mature, larvae excavate oval cells in which they turn into pupae.


Beetle Larvae

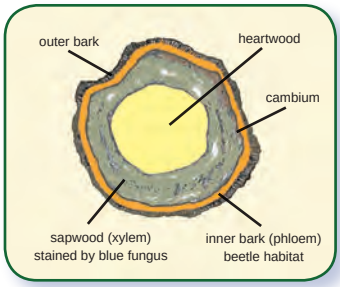

Beetle Pupae

This stage lasts for about 10 months - from August to the following June. Larvae spend the winter under the bark and are able to survive the cold by metabolizing an alcohol called glycerol that acts as an antifreeze. The larvae continue to feed on the tree until Spring, and transform into pupae in June and July. By July, the pupae usually have been transformed into adults.


Beetle Larvae and Pupae

Adults feed within the bark before they emerge; when several feeding chambers coalesce, adults occur in groups. One or more beetles will then make an exit hole from which several adults will emerge (look for numerous round, pitch-free exit holes in the bark). Within 1 or 2 days after emerging, the beetles will attack other live trees. Emergence of new adults can begin in mid-June and


Exit Holes



Tree Anatomy

continue through September. However, the great majority of beetles exit trees during late July (lodgepole pine) and mid-August (ponderosa pine).

The MPB themselves can cause the death of heavily infested trees by girdling the host tree through larval galleries. Attacking beetles also carry with them the spores of blue-staining fungi on their bodies and in a special structure on their heads. As the fungi develop and spread throughout the sapwood, they interrupt the flow of water to the tree crown. The fungi also reduce the tree's flow of pitch, thus aiding the beetles in overcoming the tree. The combination of bluestain fungi and beetle feeding rapidly kills the tree.


Bluestain Fungi

Ten to twelve months after a successful attack, infested tree foliage discolors. Soon after, the beetles are once again ready to exit and search for a new home, leaving behind a dead tree.

Evidence of Infestation

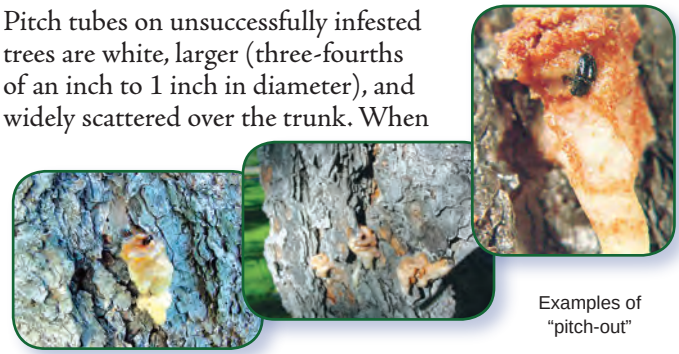
Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes are made when female beetles bore into the tree and the tree attempted to defend itself from the attack by trying to push out the attacking beetle with sap.


Pitch Tubes


Pitch Tubes

There are two types of pitch tubes. Pitch tubes on successfully infested trees are popcorn shaped and range from cream to dark-red color masses of resin mixed with boring dust, and are one-fourth to one-half inch in diameter.

Pitch tubes on unsuccessfully infested trees are white, larger (three-fourths of an inch to 1 inch in diameter), and widely scattered over the trunk. When


Examples of "pitch-out"

beetles are not present in sufficient numbers, trees can produce enough resin to "pitch out" beetles as they bore into the bark.

The MPB begins attacking most pines on the lower 15 feet of the trunk. Trees are generally killed by beetles of a single generation.


Pitch Tubes and Frass

Besides having pitch tubes, successfully infested trees will have dry boring dust (frass), in bark crevices and around the base of the tree. The frass is almost sawdust like in appearance and is the waste product of the beetle. Sometimes, however, infested trees can have boring dust, but not pitch tubes. These trees, called blind attacks or dry hits, are common during drought years when trees produce little pitch.

Peeling back a portion of bark from the tree reveals the world of the MPB. The beetle will produce "J" shaped galleries that can extend up to 30 inches in the phloem of the tree. Depending on what time of year and stage of development the beetle is in, it will be possible to find the eggs, larva or pupa living in the tree.

If any of your pine trees show any signs of these symptoms, they should be removed to prevent beetles from spreading through the forest to other live pine trees. Trees may appear green for up to 10 months after the attack but the tree is actually dead.

In firewood you may not see the pitch tubes. To check for beetles only in your firewood, peel back a piece of bark. Several logs should be sampled. This method can also be used on standing trees that may not show signs of attack, but is not recommended for trees in a urban setting or in ones yard.

The direction and spread rate of a beetle infestation is impossible to predict. However, attacked trees usually are adjacent to or near previously killed trees. The first sign of beetle-caused mortality is generally discolored foliage. Needles on successfully infested trees begin fading and changing color several months to 1 year after the trees have been attacked. The needles change from green to yellowish

green, then sorrel, red, and finally rusty brown.

- Once MPB infests a tree, nothing practical can be done to save that tree. When looking at a standing tree that has been successfully attacked by beetles, it is dead regardless of the color of the canopy.
- Under epidemic or outbreak conditions, enough beetles can emerge from one infested tree to kill at least two, and more trees the following year.
- Pine Engraver (*Ips*) and related beetles that emerge early in summer often are mistaken for mountain pine beetle, leading to early reports that "MPB is flying." Be sure to properly identify the beetles you find that are associated with your trees.

Flying MPB

Control & Prevention

Control options available for managing the MPB depend somewhat on the size of the outbreak, the age of the stand, the size of the trees, and conditions of the site.

Natural Controls of the MPB include woodpeckers and insects such as *checkered* or *clerid* beetles, that feed on adults and larvae under the bark. However, during outbreaks these natural controls often fail to prevent additional attacks.

Clerid Beetle

Checkered Beetle

Extreme cold temperatures also can reduce MPB populations. For winter mortality to be a significant factor, a severe freeze (temperatures of at least 30 degrees below zero Fahrenheit, sustained for at least five days) is necessary while the beetle is in its most vulnerable stage; in the fall before the larvae have metabolized glycerols, or in late spring when the insect is molting into the pupal stage.

Silviculture Control measures are the most common prevention/suppression methods, and the most efficient. In general, MPB prefers forests that are over-mature and dense. Managing the forest by creating diversity in age and structure will result in a healthy forest that will be more resilient and thus, less vulnerable.

Example of Forest Management and creation of "Defensible Space".

Changing forest stand conditions through forest thinning and timber-stand-improvement methods alter the beetle's habitat, so outbreaks are less likely to develop.

Patch cutting in lodgepole pine stands creates a mosaic of age and size classes, reducing the acreage of lodgepole that will be highly susceptible to beetles at any one time. Thinning lodgepole and ponderosa stands decreases competition, thereby increases stand vigor and prevents or minimizes beetle-caused mortality. Thinning also results in more erratic wind patterns which aid in disrupting the semiochemicals beetles use to communicate, thus limiting successful mating and subsequent attack on healthy trees.

Where clear or patch cutting is not feasible, selective harvesting will help reduce mortality. Trees can be harvested selectively in riparian zones and in areas along roads, in campgrounds, and around scenic vistas. Contact your local state forestry employee, or private forest consultant for assistance with forest management.

Chemical Control options are available for direct control of beetles in infested trees. Insecticides for MPB larvae have been greatly limited in recent years. Certain formulations of *carbaryl* are registered for use to prevent attacks on individual trees, and are available under several manufacturers labels. Contact your local forester or weed and pest district for available registered pesticides and their proper application. Always follow all safety guidelines on the label.

The use of insecticides in such situations requires the combined efforts of all landowners within the designated management area. However, if beetle outbreaks are large, direct chemical control may

not be cost effective: treatment costs may exceed the value of the forest product saved. At best, insecticides provide a temporary control measure that slows infestations. They will not stop an outbreak as long as the susceptible stands remain unaltered.

Trees should be sprayed to the point of run-off depending on bark thickness and texture. Ponderosa pine will probably require more chemical coverage than lodgepole pine since ponderosa has more furrowed or corky bark than lodgepole pine.

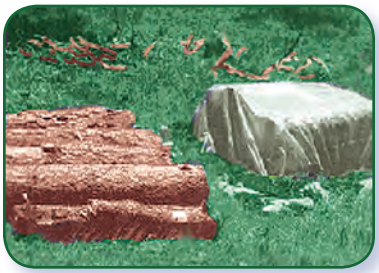
These sprays are applied to living green trees from late spring through early summer to kill or repel attacking beetles, especially for high-value trees. This preventive spray is generally quite effective through one MPB flight (one year). If this method is used, it is recommended that trees are sprayed annually.

Treatment

Logs infested with MPB can be treated directly in various ways to kill developing beetles before they emerge as adults in summer. They include solar treatment, partial peeling, chipping, burning or scorching in a pile, scoring, mill processing, debarking, burying under at least eight inches of soil, or removal - hauling infested trunks to a site at least a mile from pine forests or pine trees in an urban setting. Contact your local state forestry office or private forest consultant for assistance and information about these methods.

Solar Treatment With Plastic

Beetle mortality of 80-90% is a realistic expectation of well-designed solar treatments. For the treatment to be effective, the temperature under the bark much reach 110 degrees Fahrenheit or more. The keys to successful treatment with plastic are: 1) raising the temperature of the logs, and 2) increasing humidity and mold growth beneath the bark. Both high temperatures and mold deter and/or prevent normal beetle development. Best results are obtained from January until adult beetle emergence. This method is also labor intensive; contact your local state forester or private forest consultant for assistance with solar treatments.



Infested trees should be identified as early as possible. Since beetles fly primarily from mid-July through mid-August, detection can be done with confidence after October 1st. Cut down infested trees and remove limbs. MPB infests only the main stem of the tree, from the ground up to where the trunk narrows to about 5 inches. Cut this portion of the main stem into pieces that can be easily arranged and rolled (i.e., 4-foot long pieces).

Mold tends to grow in from the cut ends, so a higher percentage of the inner bark will get moldy in shorter pieces. Stack logs, no more than two high, off the ground with space between each log to allow adequate air flow. Place treated logs in areas with plenty of sunlight such as south and southwest facing aspects. If possible, logs should be made wet just prior to covering with plastic to enhance mold growth. (Note: this mold should not greatly reduce the wood's use as firewood if the plastic is removed in a timely manner, i.e. mid September).

Use clear plastic, not black. Clear plastic allows sunlight to penetrate and heat up the logs. Black plastic becomes hot while the logs stay cool. Choose material that is at least 6 mils thick. After covering the logs, seal the edges with surrounding soil, limbs, boards or rocks. Repair all tears and seal all seams in the plastic with duct tape. Select plastic that comes in rolls wide enough to eliminate the need for splicing.

Again, logs treated in this manner should be under plastic for a period of at least two warm months. Beetles emerging under plastic-covered logs sometimes die, and usually can't chew through the plastic and fly away. After log treatment, plastic should be removed before it deteriorates and becomes litter. Once infested, trees and logs will not become re-infested with MPB.

Burning and Scorching

Infested trees should be identified in the fall, since this

technique should only be implemented during winter months when there is adequate snow cover on the ground. Cut down infested trees and remove limbs. Cut the infested portion of the tree material (five inches in diameter or greater) into 2 to 3 foot sections. Stack in an area well away from residual trees and structures, in a single cord-wood style stack approximately 4 feet high. Pour a mix of 2/3 diesel fuel and 1/3 gasoline over the stack and ignite. Burn until all pieces are well scorched. The heat produced will kill the over-wintering larva.

The scorched wood can be used for firewood any time after the treatment, but since the wood is green, it will need some drying time. This treatment method is very effective, but handling the charred wood after scorching can be messy. If this method is used, it is very important to contact your local fire department and sheriff's office before commencing the burning.

Anti-Aggregate Pheromones

Some success in preventing beetle attacks has been achieved using encapsulated anti-aggregate pheromones. Basically the pheromone is hung from trees and essentially communicates to other beetles that *these trees have already been attacked - don't come here because there isn't any room for you.*

MCH (short for 3-methylcyclohex-2-en-1-one) is the encapsulated pheromone commonly used to ward-off the Douglas fir beetle. Another pheromone based product called *Verbenone* has been developed which repels and confuses pine infesting MPB.

Verbenone alone might be effective, but the manufacturers recommend spraying with *carbaryl* plus *verbenone* as being preferable to either treatment alone. Without *verbenone*, some emerging beetles in such close proximity to the treated area may be inclined to attack nearby trees at high enough density to overcome the insecticide. Check with your local state forestry employee, or private forest consultant for assistance with product application.

A funnel trap containing aggregative semiochemicals provides a means to assess populations of MPB.

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Death by Beetle

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