Managing Bark Beetles in Pines (MPB)

A glance at almost any forest in Montana will reveal groups of orange and red trees across the landscape. Extended drought has allowed trees to deplete soil water reserves to the point where they are severely stressed. A lack of water makes trees weak and unable to produce defense compounds that protect them from a wide variety of pests and pathogens, resulting in trees predisposed to insect and disease attackers. Perhaps the number one pest affecting pine forests is the Mountain pine beetle (Dendroctonus ponderosae). This barley kernel sized beetle bores under the bark in pine stems larger than 4” diameter to make its home and lays its eggs. Lodgepole, ponderosa, limber and whitebark pines are all susceptible. When the eggs hatch the resulting larvae feed on the growing layer of tree tissue (called the cambium) just inside the bark. Normally a healthy tree can push the intruder out by producing copious amounts of pitch that is laced with numerous secondary chemicals toxic to beetles. Drought stressed trees lack the water pressure to produce pitch and the food reserves needed to produce defense chemicals.

Beetles have also developed two strategies to overcome a tree’s defenses. First, beetles carry with them a fungus that infects the water conducting wood of the tree, blocking water transport. Infection by the fungus, which is noted by blue and black streaking in the sapwood of the tree, can by itself kill a tree. Second, these tiny beetles coordinate their attacks through the use of chemical signals (pheromones) that result in thousands of beetles attacking a single tree and overwhelming the defenses. Each pair of beetles that attacks the tree has the potential of laying over 50 eggs, that develop into mature beetles in a couple of months. If the right conditions prevail for several years beetle populations can build to epidemic proportions, which is the current state of affairs in many of our forests. For example, if two mountain pine beetles produce 50 offspring in early summer, those offspring will mate and produce 625 beetles by the end of summer. The next spring those 625 beetles will produce 97,500 beetles that by the end of the second summer will have produced 2,376,562,500 beetles!

Steps to manage MPB

1) Learn to recognize the signs and symptoms of MPB attack. Evaluate the degree of risk to pine trees on your property. Is the property close to an infested forest? Are there infested trees on your property or in the general area?

2) Practice prevention. Remove and destroy infested trees by June 1 before beetles emerge to attack nearby trees. Do not bring infested firewood onto your property. If the pine trees are at risk of attack keep them well watered.

3) If your pine trees are at risk, consider protecting them. Trees can be protected by spraying the trunks with an insecticide or by applying a repellent pheromone prior to July 1.

4) During the fall season evaluate MPB damage to your pine trees and develop a management plan that utilizes prevention and protection if necessary. The current infestation in Montana will likely last for at least another 3 to 5 more years.

Identification

Round headed and flat headed borers only rarely kill trees. They are very common in already killed trees. I would guess that the pine tree mortality you are seeing is being caused by "bark" beetles - mountain pine beetle, western pine beetle and pine engraver (ips). We do have these beetles occurring across the state in outbreak proportions, presumably due to drought. I have some on and around my property. You are correct that it only pays to spray very important trees. The standard is to coat the main stem with Sevin, which has up to 2 years effectiveness in protecting trees. When the beetle tries to bore through the bark, it ingests carbaryl and dies. Another tactic is to use "trap" trees. I currently am using this technique on my place. As part of a selective logging or thinning, drop the trees right now (actually a couple of weeks ago would have been better but now will still work), leave them lay for two - 4 weeks and then remove them. The beetles which are flying right now will infest the downed trees as they are preferred habitat. Removing the logs and selling them to the mill will then remove the bulk of the beetle population from your forest. Cautions are that the attraction caused by the downed trees will also cause some of your standing trees to be infested. Beetles are dumb and can't always tell between a down tree and the one standing next to it. Therefore try to drop your trap trees away from standing trees or drag them to a landing 100 yds from standing trees. Having a pile of fresh logs is very attractive to beeltes. It is imperative that slash be piles and then treated as well as some of the branches or small diameter nonmerchantable tops will also be good breeding grounds. Piles can be burned or sprayed with Sevin as well.

Signs And Symptoms Of Mountain Pine Beetle Attack

In Montana beetles typically fly during July and August when they attack pine trees. All species of pine can be attacked, but native lodgepole and ponderosa pine, and introduced ornamental Scots pine are preferred hosts. Hundreds of the tiny beetles bore through the tree bark and lay eggs within the inner bark. The white grub-like larvae feed on the inside of the bark. Pitch tubes produced at beetle entry points, and boring dust that accumulates at the base of the tree, are some of the first signs of attack that bec ome visible in August and September.

Figure 2 above: Scots pine tree mass attacked by thousands of beetles. At each entry point the tree exudes sap and pitch in an attempt to repel the beetle, producing distinctive “pitch tubes”. Each pitch tube represents a point of entry where a single beetle chewed trough the bark.

Figure 3 above: Trees may not always produce pitch tubes, particularly drought stressed trees that have less sap. Boring dust at the base of the tree is another sign of infestation. As the adult beetles chew and construct galleries underneath the bark they push out the dust. With hundreds of beetles at work, boring dust accumulates at the base of the tree, looking something like sawdust. Boring dust is a sign of an active infestation.

Figure 4 above: Left, after boring through the bark, female beetles construct a vertical gallery underneath the bark. When a tree is attacked by hundreds of beetles, the inner bark is destroyed by their feeding activity (middle picture). After mating, female beetles lay eggs along the vertical gallery. The eggs hatch into small grub-like larvae (upper right) that feed in a horizontal direction. The smaller larval feeding galleries radiating out from the larger vertical gallery produced by the adults produces a characteristic pattern underneath the bark (lower right hand corner).

Figure 5 above.
As mountain pine beetles bore into a tree, they bring with them blue stain fungi that colonize the tree. The blue stain commonly seen on pinewood lumber or furniture is caused by blue stain fungi. The fungi invade the inner bark as well as the sapwood of the tree trunk The picture above left is a cross section of pine tree with blue stain fungi growing towards the center. It is the combined action of the beetle feeding and the stain fungi that girdles and kills the tree. Although mass attacked trees will stay green over the winter (center picture) much like a
Christmas tree, the damage has been done. The tree is girdled, and when temperatures rise in the spring, mass attacked trees will begin to turn yellow and die from lack of water and nutrients (right-side picture). Despite the snow on the ground, the picture above right was taken during April 2009.

Will My Pine Tree Die?

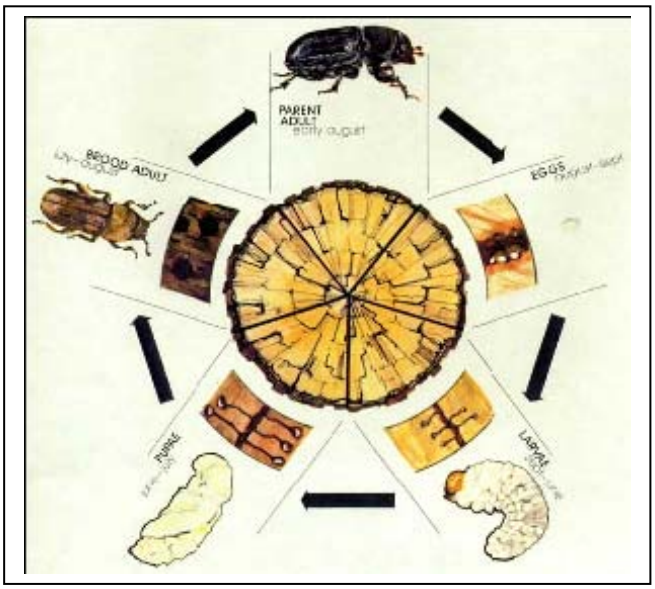
In some cases pine trees can successfully repel beetle attacks, particularly if the tree was attacked by a smaller number of beetles, such as a “strip attack”. A strip attack occurs when only one side of the tree is attacked. In a forest setting, sacrificing a few trees for the benefit of the forest is acceptable. However, in an urban setting, homeowners and landowners do not want to cut down high value trees unless they are sure that they will die. Because some trees may remain green well into the spring before they die, it is not as simple as waiting for them to turn red. Predicting the fate of “strip attacked” trees is variable and difficult. First, the trees health can be monitored into the spring season. If attacked trees turns yellow during April and May they will not survive. Second. small 1” square pieces of bark can be cut from the trunk of attacked trees on the North, East, South and West sides. If the inner bark on three or more squares is damaged, the tree will most likely NOT survive. If two or more squares have healthy bark, tree has a CHANCE of surviving. These trees may benefit from extra watering in the spring. Healthy bark is white and moist, damaged bark is brown and “chewed up”, see Figure 4 above. However, if infested trees are not removed and destroyed by July 1, they present a risk to neighboring healthy pine trees (see prevention section below).

Is My Spruce Tree At Risk?

Pine trees are the preferred host of the mountain pine beetle and spruce are at low risk. Occasionally other conifer species such as spruce and fir can be attacked. In a forest this typically occurs when beetle populations are high and there are no other hosts available (all of the pine trees have been killed during the infestation). In urban environments spruce trees right beside a mass attacked pine tree have been attacked. These cases are likely “spill over” attacks, when too many beetles are attracted to the primary host and the beetles go to the next closest conifer. In the city of Great Falls approximately 1000 attacked trees were identified and only about 6-8 were spruce trees – less than 1% of the attacked trees were spruce. Overall the risk is low, but occasionally it can occur. Also be aware that different species of bark beetles can attack spruce and fir, such as the spruce and Douglas fir beetles

Figure 6: Adult mountain pine beetles under the bark of a Scots pine tree. These are tiny beetles not much larger than a grain of rice.

Figure 7: Mountain pine beetle life cycle. Scientific Name: Dendroctonus poderosae. Hosts: Primarily lodgepole and ponderosa pines, but any pine species can be attacked. Introduced ornamental Scots pine is highly attractive to the beetle. Most of its life cycle is spent underneath the tree bark where it typically takes one year to develop through egg, larva, pupa and adult stages. Adult beetles fly during July and August attacking pine trees. Eggs hatch and larvae feed during the fall season. Immature larvae spend the winter underneath the bark. The following spring season larvae resume feeding and develop into pupae on the way to becoming the next generation of adult beetles that emerge during July and August.



What can we do to help our trees?

Tree needles often start turning red or orange a couple of weeks before the young beetles emerge from the bark, ready to attack new trees. About the time most of us start to notice a problem with a tree, it's far too late to help. Even if the beetles under the bark could be destroyed, the fungus they introduced has already been at work for many weeks and the tree can no longer transport water from roots to needles (which is why they are turning orange).

The key to protecting trees from bark beetles is to keep them healthy. Each bark beetle species prefer specific tree species and often tree age groupings. Having a landscape covered with dens trees of the same species and age provides beetles with a large food source that can breed epidemic populations. A forest with patches of different species, or age groups of trees of the same species offers a more limited food source and will stress beetle populations. For individual groups of trees, healthy means providing them with the resources they need to survive: adequate sunlight and water. Irrigating a forest during drought is obviously not possible, but reducing the number trees competing for limited resources is. Numerous scientific studies have shown that thinning dense groups of trees to an approximate 15 x 15 foot spacing dramatically increases their ability to survive beetle attacks. The best spacing between trees depends on how old, how crowded, and what species they are. A helpful spacing rule is "Diameter plus 8 feet". To determine the optimum spacing measure the average tree diameter 4.5 feet above ground level and add 8, this then gives the best spacing between tree stems in feet. (for example, a 6-inch diameter tree plus 8 equals 14-ft of spacing, whereas a 20-inch tree plus 8 requires a 28-ft spacing). Consulting with a forester is advised, especially since this often involves trees that have some commercial value that might provide you with an income. If action is taken quickly enough, infested trees can be removed before the new beetle population matures. Milling or burning the tree stems kills the beetles.

Firewood

Care should be taken when firewood is cut and transported. The beetles can continue to develop under the bark of infested firewood and emerge to attack nearby pine trees. Standing dead pine trees that are completely greybrown typically do not have living bark beetles. Trees attacked during the fall season harbor beetles until the end of August of the following year. Pine trees that are red during July and August may contain beetles. Trees cut for firewood can be inspected by removing some bark with an axe. Sign of old abandoned galleries is fine as long as there are no adult or larval beetles present (Figures 1 and 4).

Beetles can fly well over a mile, and much further if a wind is pushing them along. Mature beetles can be seeking out stressed trees during most of the summer. Usually mid to late spring is when the first major population flight

occurs, with a second flight in the middle of summer. If you have crowded or stressed trees, and evidence of bark beetle activity within a mile, there is a high likelihood that they will eventually find your trees. Early attack symptoms to look for are fine sawdust appearing in the cracks of the bark. Next, as the tree tries to defend itself, popcorn sized white and reddish pitch blobs appear on the bark of the tree. An attacked tree will have hundreds of such pitch blobs. Finally, all of the needles of the tree will suddenly turn orange. Peeling back small patches of bark down to the wood will reveal small tunnels and the wood, which is normally off white in a healthy tree, will be blue or black stained.

Prevention

If there are specific trees that a person wishes to protect, defensive insecticides can be used. Spraying forests on a large scale is not feasible from both an economic and ecological perspective. Preventive spraying of green, unattacked high value trees can be done and it is the only assurance you will have anything left when the epidemic runs its course.

Insecticides

Tree trunks need to be covered thoroughly on all sides, from ground level up to a stem diameter of about 4-5 inches. Trees can be treated from April through to the end of June. Several insecticides are available for controlling MPB: SevinXLR (agricultural/forest use), SevinSL (urban use), Astro and Onyx. All are 95-100% effective in protecting pine trees from MPB attack during the same year of application. Sevin can provide two years of protection, the year of application and the following year. Protection during the second year may be more variable, but applying Sevin once every two years may be more cost effective particularly for larger numbers of trees. Trees must be sprayed protectively, before the beetles fly and attack. Spraying trees after they have been attacked will not save them. Beetles come into contact with and ingest the insecticide when boring through the bark. Previous studies have found that systemic insecticides are not effective against bark beetles. Registered pesticide applicators are recommended; when using an insecticide carefully follow the label instructions.

This requires that the tree stem is coated with a long acting insecticide that will kill beetles that try to bore through the bark. Several studies have shown that the active ingredients Carbaryl or Cyfluthrin have been effective for one year and sometimes up to two years. The trade names Sevimol, Sevin SL and Tempo WP, and Tempo 2 have been available in many stores that carry yard and garden products. Spraying already infected trees is rarely worthwhile as beetles are under the bark and protected from surface applications. Infections detected early enough in ornamental situations have also been stopped by watering trees for 4-8 hours every week during the dry summer months.

Systemic insecticides such as the soil applied “Merit” (produced by Bayer) or Safari hold some promise though results will vary based upon soil type and application time and the scientific evidence has not been conclusive on their

effectiveness. From a theoretical perspective, soil applied insecticides should work best if applied during early spring as rain should help transport the insecticide to the roots, there is not as much time for the soil to tie up the active ingredients and the tree is in the physiological process of translocating nutrients from the roots to the stems and needles.

Insecticides applied as “injections” into the stem through drilled holes or pressurized capsules are not effective on pine trees. The same defense mechanism that trees use against beetles, “pitch” is very effective at blocking the transport of injected chemicals. One would have to bore hundreds of holes into the tree much as the beetles do to overcome tree defenses. A treatment as bad as the pest!

Protection

Prevention is helpful but alone it may not be enough. High value urban pine trees can be protected from attack using a repellent pheromone (verbenone)

Verbenone

Mountain pine beetles produce attractive and repellent pheromone chemicals when attacking pine trees. The first beetles to attack produce an aggregation pheromone that attracts other beetles in the area to “mass attack” and overcome the host tree’s defenses. When the tree is full the beetles begin producing an anti-aggregation pheromone that prevents too many beetles from attacking the same tree. The anti-aggregation pheromone, called verbenone, is sold commercially. Verbenone is sold as a liquid pouch that is attached to the tree trunk, as the verbenone evaporates beetles in the area can smell it and they are repelled. Two verbenone pouches should be attached to each high value pine tree, on the north facing side of the tree trunk about six feet high. The pouches should not be placed on top of each other, they should be spaced a few inches apart, one on the northeast side and one on the northwest side. The north side of the tree is cooler and prevents rapid evaporation of the pheromone. Commercial packaging may provide instructions for different regions in North America. In Montana MPB typically flies during July and August. For best effectiveness verbenone pouches should be applied at the end of June, before July 1.

"By using Verbenone, we can sometimes trick the beetles into thinking a tree is already infested," said Gannon. Verbenone comes in small packets that are stapled to the trunk of healthy trees.

"Verbenone can be fairly effective in low populations," Gannon said. "In esidential areas, it's best to apply two to four pouches per tree. Be sure to follow all label instructions."

Figure 8: The repellent pheromone verbenone is sold as liquid pouches that are attached to the tree trunk. In forests vebenone is spaced and applied in a grid pattern. In urban settings, high value pine trees are protected by applying two pouches per tree at the end of June, before the first of July.

USDA Forest service research has found that two pouches of verbenone applied to each pine tree at the end of June protected 80% or more of the trees that were treated (see “verbenone report” link). Please note that these recommendations are for protecting small numbers of high value trees. Recommendations for deploying verbenone in forest and woodlot settings are based on numbers of pouches per acre of forest, please refer to the DNRC Forestry Division website (http://dnrc.mt.gov/forestry/Assistance/Pests/mtnpinebeetle.asp).

Verbenone is now sold at retail stores in Montana.

Verbenone is available at retail stores in Montana or directly through two companies in Vancouver British Columbia:

Pherotech (1-800-662-8447) or www.pherotech.com and Synergy Semiochemicals Corp., (604-454-1121) or www.semiochemical.com.

Verbenone is non toxic and only affects the mountain pine beetle. It is easy to apply. However, it is not as
effective as insecticides sprayed onto the tree trunk.

Obviously, any attempts to kill beetles in infested trees are best done if supported by neighboring actions. However, this is difficult with absentee landowners, landowners who chose for whatever reason not to treat infested trees, and

uncontrolled federal lands. Preventive spraying is the only defense against a wipeout.

After you have the green trees of high value preventively sprayed, then you could do what you can to eliminate the local beetle source by treating (prior to beetle flight that begins in mid-July), the dead trees that still have beetles in them.

There is a solar technique that has been shown to be pretty effective, even at the higher elevations with lodgepole pine but this must be initiated by mid-May or early June at the latest (you need 6-8 weeks, depending on whether you are using plastic or no plastic). For the solar treatments clear plastic is recommended because beetles that emerge will be confused by clear plastic as they are attracted to light. If confined under black plastic they will be attracted to the light around the edges and escape. More information about solar treatments can be found in the following fact sheet:
http://www.ext.colostate.edu/pubs/insect/05528.html

Other options for treating infested trees prior to beetle flight are: burning, debarking, hauling to a safe site more than a mile from susceptible pine stands, and treatment with diesel fuel. Microinjections do not work well for conifers. For Douglas-fir beetle there are also anti-aggregation pheromones available through Pherotech.

How natural is this event?

Bark beetles such as mountain pine beetle are normal and natural inhabitants of our forests. Healthy trees can be killed by beetle mass attacks but this usually occurs in a very small percentage of the trees in a forest. Lodgepole pine forest are the exception as they are normally killed by Mountain pine beetles when they become overmature or crowded. Often bark beetles act as thinning agents where they “naturally” thin overcrowded groups of trees. Under conditions where large acreages support crowded trees, during drought, or when a tree is stressed by changes in the immediate environment such home building, high nitrogen lawn fertilizers, soil compaction, etc., beetles can build to epidemic populations that affect healthy trees. There are many areas currently where tree mortality is approaching 50% across forested landscapes. The same factors that have been contributing to large uncontrollable wildfires also have been allowing beetle populations to build: drought and overcrowded forests. For lodgepole pine, this is part of the survival strategy. Beetles kill the mature trees and create fuel for wildfires, the heat from which opens the fire resistant cones and prepares a perfect seedbed for the lodgepole pine seedlings. For other pine species the news is not so good. Large and severe wildfires do not benefit ponderosa pine, and promote a conversion from forest to grassland unless replanting is done after the fire.

There are more than 102 species of bark beetles specific to trees of the NW United States. Unless portions of the forest are proactively treated for tree species and age diversity that promotes individual tree vigor, such epidemics will

continue to be a part of our landscape. As a landowner, I would rather select and leave the trees that have the best chance for getting big and old and make money in the process, than have beetles decide for me which trees get left and pay money for fighting the ensuing wildfires that start and get out of control in the resulting dead trees.

Bark beetles can be identified by the larval galleries that are etched into the wood under the bark of infested trees. Shown are some of the major “tree killing” beetles.

Typical “pitch tube” tree response to bark beetle attack. A successfully attacked tree will have hundreds of such pitch masses on the stem from the base up to a 4” diameter top. Normal fall needle drop of older needles from a healthy tree

Ponderosa pines killed by bark beetles with all needles turning orange at once.

Stillwater County

Acres of Forestland, Mortality, and Defoliation by Ownership

	National Forest	Other Federal	Private	State	Total
Forestland	122,032	0	114,463	0	236,496
DFB	22	0	2	0	24
MPB-LPP	301	0	4	0	305
MPB-PP	0	0	2	0	2
MPB-High Elevation	18	0	2	0	20
SAF Mortality	12	0	0	0	12
Unidentified Defoliator	11	0	0	0	11
WSBW	6	0	24	0	30

MPB-caused mortality was observed in LPP and WBP stands administered by the Custer NF and in the Beartooth Mountains. Several groups of MPB-killed LPP were noted near Washbourn Mountains, west of Absarokee. MPB caused mortality in PP slightly declined in the County and SAF mortality also declined. Minor amounts of DFB-caused mortality were also noted. Damage caused by PTM was not mapped by ADS and landowners confirm that populations appear to be in decline. White pine blister rust has been found in WBP and LP.

Summary

Is some sort of action necessary? This is not an easy question, it relates to the degree of risk and the potential consequence. In urban environments it is difficult to predict where the beetles may turn up. However, after the beetles have mass attacked a tree, the damage has been done and there are no reliable treatments to save it. The decision is really a balance between the risk that your trees will be attacked and killed and the cost of taking action to protect them without ever knowing whether they will be attacked. Risk: How did the beetles find their way from forests to isolated shelter belts in 2008? Beetles can fly considerable distances, but they may also be aided by prevailing winds. Future occurrences in

urban environments are difficult to predict. We do know that the mountain pine beetle infestation will continue for several more years in the surrounding pine forests. If your or your neighbor's trees were attacked in 2008, it is reasonable to think that the trees are at risk again during the summer of 2009. Mountain pine beetles live in forests, the closer your location is to an infested forest, particularly if it is downwind, the greater the risk.

Links For Additional information.

www.montana.edu/pinebeetle
http://www.montana.edu/pinebeetle/

MSU Extension Service - Mountain Pine Beetle Managament (pdf)
http://www.msuextension.org/drwanner/MPB/MPB%20Managment_rev.pdf

MSU Extension Forestry Links for forest land owners Mountain Pine Bettle-
http://www.cfc.umt.edu/extensionforestry/resourcesforforestlandowners.htm

DNRC - Mountain Pine Beetle
http://dnrc.mt.gov/forestry/Assistance/Pests/mtnpinebeetle.asp

Forest Health Protection and State Forestry Organziations - Mountain Pine Beetle Managament
http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/58mtnpb.htm
http://www.fs.fed.us/r1-r4/spf/fhp/mgt_guide/mt_pine_beetle/index.html

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