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## Forest Health Protection and State Forestry Organizations

# Management Guide for Western Pine Beetle

*Dendroctonus brevicomis* LeConte

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The western pine beetle is an aggressive killer of ponderosa pine throughout its range. It also attacks Coulter pine.

### *Damaged and diseased trees are most vulnerable*

Beetle populations often attain outbreak levels when host pines are moisture stressed during drought or following forest fire. Between 1987 and 1993, western pine beetle killed over 165,000 trees in south central Idaho.

The beetle devastated stands of large, over-mature, decadent pines in the first half of the twentieth century. Western pine beetles will still infest these stands where they occur. Single, large, old, slow growing or diseased pines are very susceptible to attack. Large old ponderosa pines surrounded by second growth mixed conifer stands

are often at risk, a result of fires suppression and excessive competition from younger trees.

Over the last couple of decades the western pine beetle has become especially aggressive in second growth stands, killing trees six inches or larger in diameter, including apparently healthy trees.

Trees are characteristically killed in groups, primarily in dense, over-stocked stands of pure, even-aged pines, but mortality also occurs among dense clumps of ponderosa pines in stagnating mixed-conifer stands.

### Key Points

- Old age, drought, fire damage and disease make trees vulnerable.
- Use hazard rating to anticipate problems. Reduce hazard by removing high-risk trees.
- Thin to maintain vigor.
- Trap trees are effective in reducing local populations.

### Management

- ⇒ Silvicultural treatment; remove high-risk trees and thin to improve vigor of stands.
- ⇒ Preventative sprays can protect high-value trees, temporarily.
- ⇒ Remove and destroy brood in infested trees.
- ⇒ Pheromones can be used to lure beetles into traps or trap trees.

## *Life History*

**Female western pine beetles carry spores of blue stain fungi. The combination of blue stain fungus growth in the sapwood, and beetles tunneling in the phloem, blocks the conductive vessels of the inner bark and sapwood, resulting in tree death.**

Normal attack and development occur only in ponderosa and Coulter pine. Initial attacks on a standing tree are made about midbole and subsequent attacks fill in above and below. The beetles may take from 2 to 10 months to pass through egg, larval, pupal, and adult stages. All stages are completed beneath or in the bark of infested trees, except for a brief period when adults fly to find new trees to attack.

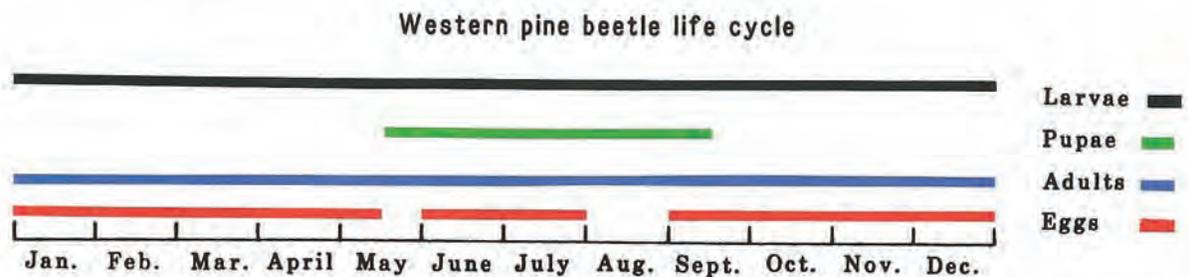
In the northern part of their range (including Idaho and Montana) and at higher elevations, the beetles produce two generations each year, with attacks concentrated in early June and late August.

During an attack period, which may last 3 weeks, each female lays about 60 tiny pearl-white eggs

individually in niches cut into the sides of the egg gallery. Some of these parent females may emerge and re attack to establish additional galleries on the same tree or in other host trees.

After incubating for 1 to 2 weeks, the eggs hatch. The larvae are small white grubs. Larvae initially feed in the phloem, where they construct a short gallery, but then mine into the middle bark where most of their development takes place.

Adults mine through the middle and outer bark, accumulating fungal spores in their mycangia (special pouches near the beetles' mouth). These fungal spores contain blue stain fungi which assist the beetles in overcoming host defenses during attack.



## *Recognizing Trees attacked by Western Pine Beetle*

Fading foliage is the first evidence of damage to the tree that is visible at a distance. Trees attacked during the summer may fade even before the beetles emerge, depending on weather conditions in any given year. In trees attacked in late summer or fall the fungus develops more slowly and many infested trees do not fade

until the following spring. Woodpeckers may flake off the outer bark of these green, infested trees as they search for and feed on developing beetle larvae. This flaking exposes the bright orange inner bark, making trees visible from as far away as 300 feet (100 m). Under the bark, the pattern of the [egg gallery](#) is distinctive.

## *Damage Prevention: The Silvicultural Approach*

Damage prevention is best accomplished by reducing hazard associated with one or more of the “high hazard” conditions through some type of stand manipulation. Alternatives include commercial thinning, or any of the several regenerative methods, which will help meet stand and site resource objectives. Any method which will

ultimately reduce stocking, stand senescence (old age) or tree damage will produce stand conditions less favorable to western pine beetle.

*A necessary first step in the prevention of beetle attacks is the identification of trees and stands most likely to support heavy populations of beetles-hence, the value of a hazard-rating system.*

## *Hazard Rating: Identifying susceptible trees and stands*

Hazard rating systems are used to help identify individual trees likely to be killed or stands more likely to experience high levels of tree mortality in the event of elevated western pine beetle

populations. Two systems have been developed for western pine beetle, one focusing on individual mature ponderosa pine trees and the other on stands of ponderosa pine.

### **Individual Tree Hazard (Miller and Keen 1960)**

A hazard rating system based on a combination of **individual tree characteristics** is used to rate mature ponderosa pines according to their susceptibility to western pine beetle attack.

- ⇒ Age
- ⇒ Crown size
- ⇒ Dominance

Applying these hazard-rating criteria, one of four levels of risk is assigned to each tree: low, moderate, high, very high. Older trees with poor thin crowns and slow growth rates are considered most likely to be attacked and killed by the beetle. Though this system was developed in California, Johnson (1972) determined it works equally well when applied to ponderosa pine stands in western Montana.

**It is important to note that hazard does not imply imminent mortality.**

**Many risk 4 (very high) trees have survived multiple periods of elevated beetle populations.**

## Stand Hazard (Steele et al. 1996)

### A combined mountain pine beetle/ western pine beetle hazard rating system for ponderosa pine.

It uses the average diameter of ponderosa pine >5" dbh (12.5 cm dbh), the basal area (ft<sup>2</sup>/acre) of the stand (all species), stand structure, and the percent basal area of host in stand.

If all ponderosa pine is < 5 inches dbh or if ponderosa pine is absent, hazard = 0. Else, assign the stand a value of high (3), moderate (2), or low (1), for each of the three parameters.

**Stand level hazard ratings are best when multiple stands are rated across a landscape, to identify areas of concentrated hazard.**

	<b>Stand Hazard; Step one</b>		
<b>Parameters</b>	<b>1</b>	<b>2</b>	<b>3</b>
<b>Average dbh of ponderosa pine*</b>	< 8 in. <20 cm	8-10 in. 20-25 cm	>10 in. >25 cm
<b>Basal area of stand (all species)</b>	<90 ft <sup>2</sup> /acre	90-120 ft <sup>2</sup> /acre	> 120 ft <sup>2</sup> /acre
<b>Stand Structure</b>	Multi-aged (> 2 stories)	Dual-aged (two storied)	Even-aged (single storied)
* average diameter at breast height (3.5 ft.) of ponderosa pines that are at least 5 in. dbh.			

**Step two:** Add the stand hazard values for each parameter, then multiply by the percentage of ponderosa pine > 5" (10 cm) dbh in the stand.

Hazard rating can be displayed using maps to detect areas of concentrated hazard, especially areas where beetle caused mortality would adversely impact ability to achieve management goals. Such hazard maps enable land managers to prioritize areas for treatment to reduce hazard.

## *Silvicultural Treatments*

### Old Growth Stands

The most effective means of reducing losses to the western pine beetle in old growth ponderosa pine stands is through the application of individual tree hazard rating techniques ([Miller and Keen 1960](#)) with subsequent removal of high-risk trees. In stands where high-risk tree removal strategies have been implemented, beetle-caused mortality has been reduced by as much as 70 percent.

### Second Growth Stands

Management strategies that reduce [stand hazard ratings](#) often increase the vigor of residual trees and result in lower losses to the western pine beetle. The one stand characteristic used in hazard rating most amenable to silvicultural manipulation is density. Thinning the trees will increase tree vigor and reduce the risk of beetle attack in remaining trees. Reducing the basal area to 90-100 square feet per acre is an effective guideline. A general rule of thumb is to remove enough trees so that the tree crowns do not touch.

Rapid vigorous growth increases host resistance and reduces the likelihood of outbreaks.

**In both old growth and second growth stands, trees weakened by defoliation, root disease, lightning, fire, mechanical injury, breakage, soil disturbances, or attack by other bark beetles are very susceptible and should be removed as quickly as possible.**

### Natural Control

Climatic conditions and host resistance most often determine western pine beetle abundance. Winter temperatures of -20 F and lower for a few days have been found to cause heavy mortality to overwintering broods. Drought, which stresses trees, promotes beetle survival and the development of outbreaks. Rapid, vigorous tree growth increases host resistance and reduces the likelihood of outbreaks.

While woodpeckers and insect enemies of the western pine beetle do exert pressure on western pine beetle populations, these natural enemies have not been shown to effectively cause an outbreak population of the beetle to collapse.



Predatory beetles help to keep bark beetle populations in check. The first sign of attack may be predacious checkered beetles seen at eye level scurrying over the bark in search of western pine beetle prey.

## *Direct Control*

Direct control measures focus on killing beetles and may be justified in areas where beetle caused tree mortality is incompatible with management objectives such as home sites, campgrounds, or recreational areas. Felling the infested tree and immediately burning, debarking, or spraying it with toxic chemicals can kill beetle broods.

If the larvae are well developed, debarking alone will not kill them, the bark would need to be burned or otherwise destroyed. If western pine beetle infested ponderosa pine is used for fire wood, the fire wood needs to be used (at least the bark) before the adults can emerge in the spring or they may attack and kill nearby pines.

## *Preventative Sprays*

Certain insecticides may be applied to susceptible trees prior to beetle flight and will successfully protect trees from attack. Check with your local Forest Health Protection Office or State/County officials to determine which

insecticides are currently registered for this application.

Beetles initially attack a standing tree about midway up the bole with subsequent attacks filling in above and below- so preventative sprays need to cover as much of the trunk as possible.

## **Pheromone Strategies**

**The aggregation pheromone for the western pine beetle has been identified and synthesized for use in management strategies.**

Aggregation pheromones are compounds produced by the beetles which call to other beetles in the vicinity to aggregate to facilitate successful mass attacks on hosts. Western pine beetle baits have numerous potential applications including:

- ⇒ **Trap out Strategies:** pheromone baited traps or trap trees are used to concentrate beetles in an area slated for management. Traps are routinely maintained/ emptied or trap trees are promptly removed to prevent beetles from completing their lifecycle and attacking additional trees.
- ⇒ **Tree baiting:** in certain areas tree baits are being used to selectively remove certain ponderosa pine. In the Northern Region tests are ongoing to determine the potential to use western pine beetle tree baits to kill off site ponderosa pine.
- ⇒ **Baited toxic trap trees:** in this scenario a tree is treated with an insecticide than baited. Beetles fly to the bait and then ingest the insecticide and die.

## Recognizing Western Pine Beetle

Inconspicuous white to reddish brown pitch tubes  $\frac{1}{4}$  to  $\frac{1}{2}$  inch (6 – 13 mm) in diameter, may be formed on the tree trunk around entry holes made by attacking female beetles. More frequently the first visible sign of successful attack is reddish boring dust that accumulates in bark crevices and around the base of trees. Egg galleries wind both

laterally and longitudinally, crossing and recrossing each other in a maze-like pattern which is unique among bark beetles infesting ponderosa and Coulter pine. The life stages are similar to other species in the genus, the adult being dark brown to black and slightly less than one-quarter inch long.



Western pine beetle gallery in cambium.

## Other Reading

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### Forest Health Protection and State Forestry Organizations

#### Assistance on State And Private Lands

Montana: (406) 542-4300

Idaho: (208) 769-1525

Utah: (801) 538-5211

Nevada: (775) 684-2513

Wyoming: (307) 777-5659

#### Assistance on Federal Lands

US Forest Service  
Region One

Missoula: (406) 329-3605  
Coeur d'Alene: (208) 765-7342

US Forest Service  
Region Four  
Ogden: (801) 476-9720  
Boise: (208) 373-4227

