Forest Insect & Disease Leaflet 5

United States Department of Agriculture

Forest Service

Douglas-fir Beetle

Richard F. Schmitz and Kenneth E. Gibson

Figure 1. Group of trees killed by Douglas-fir beetles.

The Douglas-fir beetle (*Dendroctonus pseudotsuqae* Hopk.) infests and kills Douglas-fir throughout most of its range in western United States, British Columbia, and Mexico. Occasionally western larch trees are infested when growing among Douglas-fir under attack. Attacks in standing larch are always unsuccessful, while those in freshly felled larch are usually successful and brood emergence is equivalent to that in Douglas-fir.

Douglas-fir beetles normally kill small groups of trees, but during outbreaks 100 tree groups are not uncommon (fig. 1). Losses can be devastating during periodic outbreaks, such as four that occurred in western Oregon and Washington from 1950 through 1969, during which 7.4 billion board feet of timber were killed. Outbreaks in standing trees range from 2 to 4 years. Those of longest duration coincide with periods of drought. For example, thousands of acres of Douglas-fir supported outbreaks in several western states following a drought from 1986 through 1988. In 1966, an outbreak in California killed 800 million board feet of timber and an outbreak in Idaho killed 109 million board feet of Douglas-fir between 1970 and 1973.

At low or endemic levels, the beetle infests scattered trees, including windfalls and trees injured by fire-scorch, defoliation, or root disease. Where such susceptible trees are abundant, once they have been infested and killed, beetle populations can build up rapidly and spread to adjacent green, standing trees. Damage is greatest in dense stands of mature Douglas-fir. Various fungi introduced by the beetles also contribute to mortality of infested trees.

Figure 2. Reddish-orange frass expelled from entrance hole in bark crevices is the first indication of beetle attack.

External Evidence of Infestation

Reddish-orange frass, consisting of fragments of phloem (inner bark) expelled from bark crevices by invading beetles, is the first sign that a tree has been attacked (fig. 2). Because wind and rain remove the frass, and attacks may be well above eye level, a tree must be examined carefully to determine if the beetles are present. Additionally, not all attacks are successful, especially in living trees. Attacking beetles are sometimes pitched out by resin flows. At times, the most evident sign of attack is the clear resin exuding from entrance holes on the stem at the upper limit of infestation. Pitch flow, however, is not always present on successfully attacked trees (fig. 3).

Several months after a tree is successfully infested, its foliage becomes discolored (fig. 4). First the needles turn yellow, then sorrel, and finally reddish brown. Although some trees are discolored as early as August,

Figure 3. Clear resin flow (pitch streamers) exuding from attacks at the uppermost infested portions of the tree bole.

Figure 4. Discolored needles on infested trees first turn yellow, then sorrel, and finally reddish-brown.

others may remain green until the following June. The time of year that this discoloration becomes visible varies with locality, date of attack, intensity of infestation, elevation, and seasonal weather. Usually needles are shed and conks of the pouch fungus, *Cryptoporus volvatus* (Pk.) Hubbard, form on the outer bark during the year following infestation. Needles begin to fall from infested trees the year following attack but becomes more noticeable the second year after infestation.

Figure 5. Adult Douglas-fir beetle.

Description of Life Stages

Adult Douglas-fir beetles are stout, cylindrically shaped, and 4 to 6 mm long (fig. 5). The head and thorax are black; the wing covers reddish brown, becoming darker with age. The whitish eggs are 1 mm long (fig. 6). Eggs hatch into white, legless larvae with shiny, light-brown heads (fig. 7). Mature larvae transform into pupae before becoming adults. Pupae are white, mummy like, with some adult features, including wings that are folded beneath the abdomen.

Figure 6. Eggs are whitish, cylindrical, and deposited along edge of the egg gallery.

Seasonal History

The Douglas-fir beetle has one generation per year. Broods remain in the tree and overwinter mainly as adult beetles, but also as larvae. Initial adult flights vary from year to year with location and weather, but most new attacks take place in mid- to late-spring. Larvae that have overwintered complete their development and emerge as adults in the summer. Also, some adults that emerge and make early-spring attacks, re-emerge and make a second attack, usually in late June and July, sometimes continuing into August. Typically, late-season attacks account for less than 20 percent of all attacks in one season.

Figure 7. Douglas-fir beetle larvae.

Figure 8, The female lays groups of eggs, alternating deposition between opposite sides of the egg gallery.

Galleries and Characteristics of Infestation

The distinctive egg galleries are constructed by the female beetles which bore through the bark and tunnel upward in the phloem, lightly engraving the sapwood. These galleries run parallel to the wood grain, commonly for lengths of 8 to 10 inches (20.3 to 25.4 cm). They are somewhat longer in windthrown trees. Galleries are packed with frass except at the top where the beetles are actively tunneling. The females lay groups of eggs alternately along opposite sides of the galleries as construction progresses (fig. 8). The eggs hatch in 1 to 3 weeks, depending on seasonal temperatures. The newly hatched larvae mine outward from the egg gallery in the phloem (fig. 9). These mines are visible on the inner surface of the phloem and increase in width as larvae molt and grow through four stages. During the final stage of development, larvae construct pupal cells at the ends of their mines that usually extend into the inner bark.

Tree stems are infested for varying lengths, but seldom higher than a top diameter of 6 or 8 inches (15.2 or 20.3 cm). Other bark beetles, *Scolytus monticolae* Swain, *Scolytus unispinosus* (LeConte), and *Pseudohylesinus nebulosus* (LeConte), often occur in the top of the stem. In standing trees, Douglas-fir beetle egg galleries are usually more dense and the brood survival higher in the middle portion of the in-

fested stem. In windthrown trees, egg galleries tend to be uniformly successful, but are generally more dense on the shaded underside. Generally, Douglas-fir beetle attacks are more dense, and success rate higher, in down trees than standing ones.

Figure 9. Characteristic gallery pattern resulting from larvae mining the inner bark.

Control

The resistance of live trees to bark beetle attack is the most important naturally occurring factor controlling outbreak development.

Climate and weather also strongly influence survival of Douglas-fir beetle populations. Natural enemies include many parasitic or predacious insects, nematodes, and mites. Woodpeckers are not important predators of the beetle.

While it is feasible to kill developing beetle broods with chemical insecticides, such a "direct control" strategy is not likely to be recommended. The most desirable management approach, therefore, involves prompt detection of blowdown or other stand disturbances, timely removal of threatened or infested trees, and maintenance of a vigorous stand.

The best "control" of a Douglas-fir beetle outbreak involves pro-active management to prevent its occurrence. Although outbreaks typically last but 2-4 years, many standing trees may be killed before beetle populations naturally subside; and there is a tendency for their re-occurrence until stand conditions favoring outbreaks are changed. That being the case, the most effective strategies are preventive and involve reducing stand susceptibility to beele infestations. Likelihood of an infestation developing within a stand is related to the proportion of susceptible Douglas-fir and overall stand density. Generally, in

unmanaged stands, attacks are most successful on trees that are mature or overmature, largest in diameter, and found in more densely stocked stands. A very high stand density may increase the susceptibility of younger and smaller-diameter trees. The higher the proportion of trees with "susceptible" characteristics, the higher the susceptibility of the stand to beetle attack. Correspondingly, silvicultural manipulations which reduce the proportion of the stand having those characteristics limit beetle-caused damage. Prompt salvage of blowdown or currently infested trees will also help forestall epidemics. Because of the beetles' preference for downed trees; trap trees, used early in an outbreak sequence, can reduce beetle-caused mortality in standing trees.

Stands being brought under management should be assessed for presence and extent of root diseases. A high incidence of root disease in host trees often results in high endemic beetle populations. In such circumstances, stand disturbances may trigger outbreaks which develop more quickly and are longer lasting.

Semiochemicals (message-bearing chemicals), emitted by the beetle and the host tree upon attack, regulate the behavior of beetles during their mating and aggregation phase. Certain elements of beetle-produced pheromones, when combined with specific host monoterpene odors, serve to guide additional flying beetles to the tree and ensure that they are concentrated in sufficient numbers to overcome resin defenses of the tree. The attractive elements have been combined into a lure that is effective in aggregating adult beetles when placed on suitable host trees. Concentrating attacking populations can make salvage or sanitation logging more effective.

Other elements of this pheromone complex serve to disrupt aggregation and thereby ensure attack densities are optimum for brood survival. Release of this antiaggregating component also serves to divert responding beetles to nearby trees, resulting in the characteristic group-kill pattern. The antiaggregative component has been used experimentally to reduce the level of attack and survival in windthrown trees well below optimum levels. Its usefulness for protecting standing green trees has also been successfully tested.

Use of synthetic pheromones for beetle suppression is subject to registration by the Environmental Protection Agency. The Agency has determined that the aggregative pheromone applied to trees is exempt from registration. Registration of the antiaggrative component is pending. Field tests to measure the effectiveness of these synthetic pheromones and determine their most effective deployment are under way. Check with federal or state forest entomologists for current recommendations.

Long-term management of Douglas-fir forests offers the best method of preventing or minimizing damage by the Douglas-fir beetle. Young stands should be thinned periodically to maintain vigorous growth, reduce moisture stress, and remove trees injured by wind, disease, and other agents. Managed stands which are mature or overmature should be regenerated. Successful preventive practices must also include salvage of windthrown or infested trees before beetle broods emerge from them.

References

Furniss, Malcolm N. 1979. An annotated bibliography of the Douglas-fir beetle,

Dendroctonus pseudotsugae Hopk. USDA For. Serv. Gen. Gech. Rep. INT-48, 40 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Furniss, Malcolm M.; McGregor, Mark D.; Foiles, Marvin W.; Partridge, Arthur D. 1979. Chronology and characteristics of a Douglas-fir beetle outbreak in northern Idaho. USDA For. Serv. Gen. Tech. Rep. INT-59. 19 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Furniss, Malcolm, M.; Livingston, R. Ladd; McGregor, Mark D. 1981. Development of a stand susceptibility classification for Douglas-fir beetle. In Hedden, R.L., Barras, S.J., Coster, J.E., compilers. Proceedings: symposium on Hazard Rating Systems in Forest Pest Management, July 31-August 1, 1980, USDA For. Serv., Gen. Tech. Rep. W.O. 27, 169 p.

Furniss, R.L. and V.M. Carolin. 1977. Western forest insects, USDA For. Serv. Misc. Pub. No. 1339, 654 p.

The United States Department of Agriculture (USDA) Forest Service is a diverse organization committed to equal opportunity in employment and program delivery. USDA prohibits discrimination on the basis of race, color, national origin, sex, religion, age, disability, political affiliation and familial status. Persons believing they have been discriminated against should contact the Secretary, U.S. Department of Agriculture, Washington, D.C. 20250, or call 202-720-7327 (voice), or 202-720-1127 (TDD).

Revised June 1996

R1-96-87

Pesticide-Information Disclaimer

This page has been added; it is not part of the original publication.

****

This USDA Forest Service *Forest Pest Leaflet* (FPL) or *Forest Insect & Disease Leaflet* (FIDL) - both representing the same publication series - has been reproduced in whole from the original publication as a service of the Montana Department of Natural Resources and Conservation (DNRC) Forest Pest Management program. Both FPLs and FIDLs contain useful and pertinent information on forest insect and disease biology, identification, life cycles, hosts, distribution, and potential management options.

Some FPLs and FIDLs, however, discuss and (or) recommend pesticides that are no longer registered with the U.S. Environmental Protection Agency or are no longer available for use by the general public. Use of these pesticides is neither recommended nor endorsed by the Montana DNRC.

Before using any pesticide be sure to consult either a forest health specialist; state extension agent; your state's Departments of Agriculture, Natural Resources, or Forestry; or other qualified professional or agency with any questions on current pesticide recommendations for forest insects and diseases.