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ABSTRACT

Efforts to suppress mountain pine beetle (*Dendroctonus ponderosae* Hopkins) epidemics in Colorado have been carried out since the early 1900s using various methods of treating or removing beetle populations. These methods have slowed the rate of annual tree losses, but have done little to reduce total tree mortality over the course of an infestation, or to reduce the susceptibility of the stands to additional beetle attack. Based on recent research findings that demonstrated the importance of lodgepole pine (*Pinus contorta* Douglas var. *latifolia* Englemann) phloem thickness and diameter in mountain pine beetle epidemics, stands in the Middle Park area of Colorado were cut using strategies to reduce stand susceptibility to beetle attack. Partial cutting and clearcutting, combined with the logging of infested trees, were used to reduce the inventory of larger-diameter trees. Other factors considered were dwarf mistletoe, comandra rust and visual management concerns. Losses in partial-cut areas have been reduced to 1 to 2 percent of the residual trees, whereas in unmanaged stands 39 percent of the trees have been lost.

INTRODUCTION

Mountain pine beetle (*Dendroctonus ponderosae* Hopkins) epidemics in lodgepole pine (*Pinus contorta* Douglas var. *latifolia* Englemann) stands throughout much of the Rocky Mountains usually last between 5 and 7 years. During this period, tree mortality increases from about 1.25 trees per ha (0.5/acre) to a peak of over 62.5 trees per ha (25/acre) in 3 to 4 years, then declines to less than 1.25 per ha during the next 2 to 3 years. The cumulative effect on the stand is drastic. Tree losses range from 60 percent of the 30 cm (12 inch) dbh class to about 90 percent of the trees 40 cm (16 inch) dbh and larger. Total stand mortality may average 33 percent or greater (trees 15 cm dbh and larger).

Lodgepole pine stands in the Middle Park of central Colorado are no different from those in other areas in that they have been "blessed" with mountain pine beetle infestations since at least 1910, the date of the first reported infestation. From 1915 to 1921, "cut and peel" was the most common treatment and was accomplished at the forest district level on a day-by-day basis. From 1933 to 1937, large-scale treatments were applied by the Civilian Conservation Corps. Infestations continued on a somewhat regular basis, with the current infestation beginning about 1963. Some effort was made to "control" the mountain pine beetle in 1964 and 1965; the effort was limited to clearcut sales and ethylene dibromide chemical treatments (see Klein these proc.).

The question that remained throughout these years was, "Do effective control measures exist?" Efforts to control populations of mountain pine beetle in lodgepole pine by chemical spraying, salvage logging or combinations of both treatments were evaluated recently (Amman and Baker 1972). Beetle populations declined in about the same number of years, whether or not control was attempted, and tree losses were similar for lodgepole pine stands having similar characteristics.
Techniques such as chemical spray, either preventive or insecticidal, salvage logging and logging of infested trees do not have, to any great extent, a lasting effect on either the course or the duration of an infestation or on the potential for population build-ups. Susceptibility of the stand to beetle epidemics remains because stand characteristics remain essentially the same.

**A MANAGEMENT APPROACH**

The basic problem facing the land manager is how to reduce the probability of beetle epidemics developing within particular stands of lodgepole pine. As is well documented, both in the literature and as presented at this symposium, epidemics are definitely correlated with the presence of large-diameter, thick-phloemed trees, and beetle brood production is correlated positively with phloem thickness.

Cole and Cahill (1976) stated, after measuring several Colorado stands of lodgepole pine, that epidemics are not as likely to occur in stands where the proportion of 20 cm (8 inch) dbh and larger trees containing phloem 0.28 cm (0.11 inch) thick or thicker is 20 percent or less. Therefore, the distribution of phloem thickness over diameter classes can be an effective measurement for evaluating infestation potential in a lodgepole pine stand. Guidelines for reducing losses of lodgepole pine to the mountain pine beetle have been developed, based on ecological relationships of the beetle to its host (Anman et al. 1977, Safranyik et al. 1974).

A management approach to reduction of lodgepole pine losses to the mountain pine beetle has been used within stands in the Middle Park area of Colorado from 1972 to the present time. During this period, 2600 ha (6500 acres) of lodgepole pine were cut, including 1600 ha (4000 acres) of partial cuts. The total volume removed was 42 million board feet.

**Clearcutting to Reduce Losses**

Clearcutting is the best silvicultural system for lodgepole pine and was used in the Buffalo Peak area to prevent losses to the beetle. This area had a large number of trees in each diameter class that contained thick phloem. For the stand, one-third of all phloem samples were thicker than 0.28 cm—a high beetle-producing capacity. The probability of 30 cm dbh and larger trees containing phloem 0.28 cm or thicker was 0.72; 25 cm and larger trees had a probability of 0.51; 20 cm and larger trees had a probability of 0.45. Consequently, in such stands, where even small-diameter lodgepole trees have a high potential for maintaining the beetle epidemic, clearcutting is the best strategy.

In another area of low to moderate visual impact, clearcutting was used because of stand size and high mistletoe rating. These clearcut patches were small and generally under 16 ha (40 acres) in size.

**Partial Cuts to Reduce Losses**

Where clearcutting is restricted, partial cutting can be used effectively. Alexander (1975) modified his recommendations for partial cutting in old-growth lodgepole pine stands to consider dwarf mistletoe, comandra rust and mountain pine beetle. Some recommendations for dealing with mistletoe and comandra (Brown 1977) are compatible with those for mountain pine beetle. These causes of mortality of lodgepole pine, as well as windfall, place rather severe limitations on the management of this species. Economics can also limit choice of activity. As Alexander states, "Cutting to bring old growth under management is likely to be a compromise between what is desirable and what is possible."

Based upon Cole and Cahill's (1976) work, attacked trees and all or most of the trees 30 cm dbh and larger should be cut first within susceptible stands. Then as many of the trees in the 25 to 30 cm dbh class, regardless of vigor, should be removed to make up the remainder of the basal area to be cut. A second cut should follow within 10 years. The susceptibility of a stand can be reduced for a longer period of time by removing all trees 20 cm dbh and larger. However, stocking and stand productivity should be of prime concern when making partial cuts.

Over 1600 ha were partial-cut on Bureau of Land Management and private lands to reduce losses to the beetle. Partial cuts were used in areas of visual concern that possessed high potential for beetle build-up and in stands adjacent to clearcuts in order to avoid having extensive clearcut areas. A do-nothing strategy was adopted for stands on steep hillsides and for inaccessible areas.

Loss to the mountain pine beetle has been greatly reduced in these cut stands. Surveys showed the trend of loss to be static to decreasing following tree harvest. In the stands where nothing was done, infestations of the beetle continued. Losses to the beetles were expected to be from 35 to 55 percent of the stems 15 cm (6 inch) dbh and larger; however, accumulated losses after partial cuts were only 1 to 2 percent of the residual trees. In the do-nothing area, 39 percent of the trees, or 52 percent of the basal area, was lost to the beetles.

**CONCLUSIONS**

Cutting practices within lodgepole pine stands should be primarily concerned with maintaining continuity of cover, yet silvicultural systems, stand structure, site, habitat, wind, diseases and insects all limit the available options. Clearcutting is the best silvicultural system for lodgepole pine. Where its use is restricted, however, partial cutting can be used effectively. Partial cutting to remove 50 percent or less of the basal area will provide openings for regeneration, minimize windthrow, help control dwarf mistletoe, remove the majority of the food supply of the mountain pine beetle and, if designed properly, maintain scenic values.
QUESTIONS AND ANSWERS

Q. Where 50 percent cuts were undertaken, what incidence of blowdown was noted within a 5-year period following harvest? In general, do you have a specific percent recommendation to best serve multiple-use objectives?

A. The stands cut to 50 percent of basal area were areas classed in low windfall risk situations by Alexander's "Partial Cutting in Old-Growth Lodgepole Pine." This is heavier than he recommends. In these cuts we had about 2 percent mortality over the 5-year period. In reference to recommendations that best serve multiple-use objectives, the individual land manager has the best understanding of his particular needs and should develop the specifications accordingly.

Q. When partial cutting, what about mistletoe in future regeneration?

A. The publication entitled "Guidelines for Dwarf Mistletoe Control in Lodgepole Pine in the Northern and Central Rocky Mountains," Report No. 76-14, August 1976 (Dooling and Brown, Forest Service Region 1, Missoula, MT), provides detailed guidelines for management of mistletoe-infested stands. In summary, the land manager must use partial cutting practices where the maintenance of a continuous forest cover is required; however, partial cutting generally produces ideal conditions for intensification and subsequent damage by dwarf mistletoe.

When dwarf mistletoe is present in stands where partial cutting is proposed, the following cutting modifications are recommended (Alexander 1975):

In old-growth stands with an average mistletoe rating greater than Class 2, any partial cutting, thinning or cleaning is likely to intensify the infection. The best procedure, therefore, is to either remove all of the trees and start a new stand or leave the stand uncut. If the manager chooses to make a partial cut for any reason, the initial harvest should be heavy enough to be a regeneration cut. All residual trees must be removed within 10 years after the first to avoid infection of the regeneration.

Weeding and thinning are cultural methods used to release crop trees from competition and accelerate their growth rate. These methods will have varying effects on dwarf mistletoe infection, depending on how and when they are applied and the condition of each stand. Most stands with an average dwarf mistletoe rating of Class 2 or less will benefit from treatment and produce acceptable yields. Tree density and intensity of dwarf mistletoe are two key factors that determine the feasibility of thinning. Stands with heavier stocking levels can tolerate higher levels of dwarf mistletoe and still produce acceptable yields. For infested stands of precommercial age, more favorable management options are available when stand densities exceed 2500 trees per ha (1000/acre). By utilizing RMYLD (a computerized yield program), the land manager can select the appropriate silvicultural treatment for each stand and rank stands by priority.

Q. There appears to be quite a difference in your results as compared with Hamel's from similar treatments. Any explanation? Were there infested areas around your stands?

A. The Middle Park area was cut on a stand-by-stand basis compared with Region 1, where blocks were cut in the middle of stands and the check areas were in several cases adjacent to the same stands, thereby subjecting the treated areas to beetles building up in the check areas. Also, the Colorado area was cut at the beginning of mountain pine beetle build-up in the area, whereas a large beetle population was present in the Montana area. Most of the Colorado area was treated to remove mountain pine beetle host-sized trees, compared with several small blocks in Montana.

Q. Due to the annual occurrence of fires and the resultant species conversion to lodgepole pine stands, would you consider complete stand conversion (from lodgepole pine) as a viable management goal wherever possible? Was lodgepole pine reintroduced to your clearcut blocks?

A. I would consider stand conversion of some sites but not all sites. The decision to make stand conversion is dependent upon your future timber needs and what species is best adapted for a particular site. The threat of insect...
and disease losses should also be a consideration. What will be the market needs—studs, lumber or fiber, etc.? Yes, lodgepole pine was reintroduced in most of the sites but other species of trees are present on some sites (spruce, Douglas-fir or white bark pine).

Q. Were your tree losses actually reduced in your partial cut areas when you consider the basal area you were forced to remove in the logging operation? Are you just removing trees that would have been hit anyway?

A. Yes! The tree losses were reduced and, yes, we removed most of the trees that would have been hit by mountain pine beetles, thereby preventing a build-up of the beetle population. The cutting system outlined provides a guide to determine which trees are susceptible to attack and the greatest producers of beetle broods. These should be removed from the stand. Most operators prefer green sales rather than salvage sales.

REFERENCES


THEORY AND PRACTICE OF MOUNTAIN PINE BEETLE MANAGEMENT IN LODGEPOLE PINE FORESTS

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