PREVENTIVE STRATEGIES FOR LODGEPOLE PINE/MOUNTAIN PINE BEETLE PROBLEMS: OPPORTUNITIES WITH IMMATURE STANDS

Dennis M. Cole

ABSTRACT: Culture of immature lodgepole pine stands is seen as a critical part of long-term prevention strategies for reducing future resource losses from the mountain pine beetle. This paper describes applicable practices for immature stands and discusses their strategic role in attaining a forest-wide mosaic of stands varying in age, size, composition, and structure. A diverse forest mosaic is considered necessary for avoiding severe mountain pine beetle outbreaks in commercial forests.

INTRODUCTION

Strategies to minimize losses to the mountain pine beetle (Dendroctonus ponderosae Hopk.) include a variety of practices that differ in intent and effectiveness. Some seek to reduce losses by prevention, some by recovery and utilization of otherwise lost trees, and others by amelioration of effects. A diagram classifying practices, intents, tactics, and strategies for controlling losses to the mountain pine beetle (MPB) in lodgepole pine (Pinus contorta var. latifolia) forests was developed earlier (Cole 1978). The practices discussed in this paper include those prevention tactics identified in that classification (fig. 1).

Although this topic associates strategies with stands, it is really the forest, over time, that we are concerned with in developing prevention strategies for reducing losses to the mountain pine beetle. This distinction focuses the generalized goal of reducing losses to the specific objective that will accomplish it--namely the management of endemic mountain pine beetle populations to prevent their increase beyond endemic levels. This means that strategies for immature stands must be developed and executed as an integral part of ongoing, long-term, forest-wide programs for managing the age, structure, composition, and vigor of stands--and their juxtaposition across the landscape--to keep mountain pine beetle populations endemic. Such programs will include (along with strategies for immature stands) silvicultural strategies for mature/overmature stands as discussed earlier in this symposium, and utilization and chemical intervention strategies to be discussed in following papers. The overview and field trip discussions of silvicultural and resource management strategies for addressing the mountain pine beetle problem on the Swan Lake Ranger District of the Flathead National Forest will illustrate and provide context for many of the points discussed in this and the other papers.

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Dennis M. Cole is Research Silviculturist, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Bozeman, MT.

The objective of this paper is to review appropriate silvicultural practices and strategies for minimizing future resource losses from the mountain pine beetle, in relation to immature stands. The stand--and often the individual tree or tree type--is the focal point in applying most of the cultural practices discussed; but to emphasize the critical forest-wide perspective needed in this issue, the focus here will be on opportunities for increasing future forest diversity through management of immature stands. Such diversity benefits nearly every resource of concern and is particularly important in minimizing forest losses from insects and disease.

APPLICABLE STAND-TENDING PRACTICES

Cultural practices for immature lodgepole pine stands have been identified for years (Smithers 1961; Tackle 1961). More recently, their role in the battle against the mountain pine beetle has been described (Cole 1978; Cole and McGregor 1985; Safranyik 1982; Safranyik and others 1974). Several practices for immature stands can contribute to the avoidance of future outbreaks of the mountain pine beetle. They are:

- Improvement and Sanitation Cuts
- Manipulation of Stand Density, Composition, and Structure
- Early Stand Replacement

Although not large in number, the flexibility in scale, scope, and timing of these operations provides the manager with an effective set of tools for affecting future forest diversity.

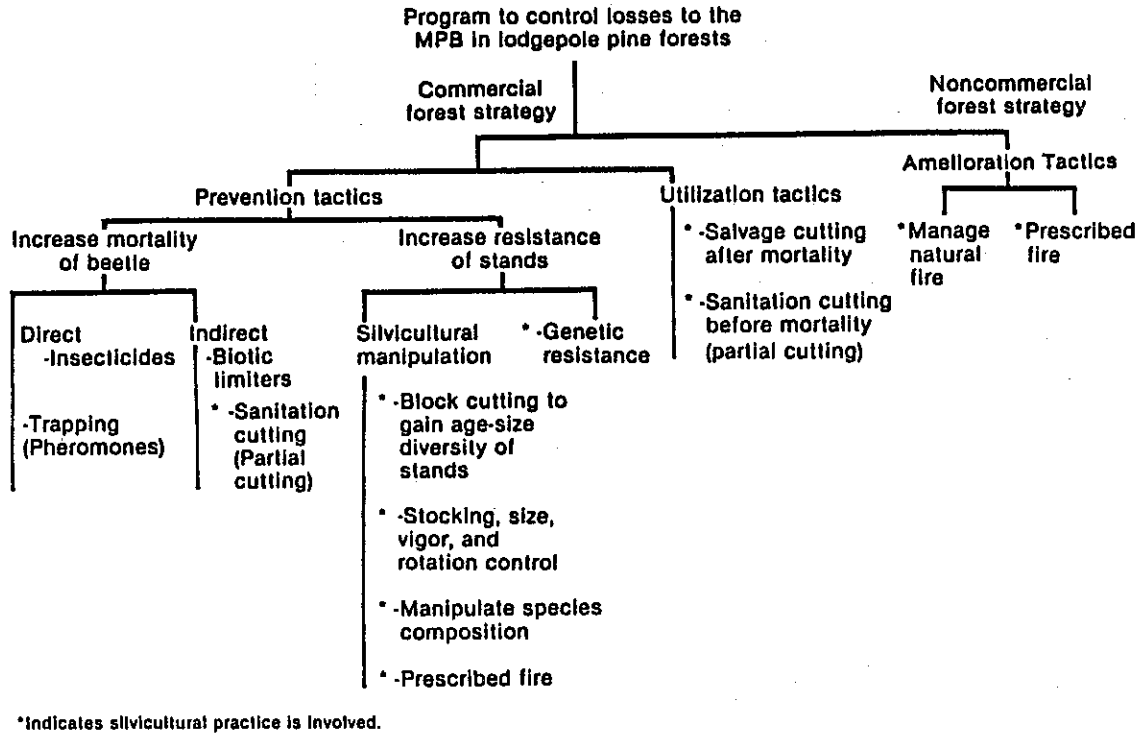

Figure 1--Place of immature-stand culture in strategies for controlling losses from the mountain pine beetle (from Cole 1978).

Improvement and Sanitation Cuts

Improved health of even-aged and uneven-aged lodgepole pine stands can be attained by stand tending keyed to detecting and removing diseased, damaged, or otherwise unhealthy trees. Many disease and damage effects occur in immature lodgepole pine stands (Krebill 1975; Lotan and Perry 1983); however, only lodgepole pine dwarfmistletoe (Arceuthobium americanum), wind, and snow warrant special mention. Stem rusts and root diseases can be locally debilitating in some lodgepole pine stands and predispose affected individual trees to bark beetle attack (Christiansen and others 1987), but effective control measures are not yet known (van der Kamp and Hawksworth 1985).

Dwarfmistletoe infection can predispose trees and stands to bark beetle attack by reducing tree and stand vigor. Ideally, dwarfmistletoe should be excluded from lodgepole pine stands in the regeneration phase of management. Where regenerated stands less than 20 years old occur with scattered infected residual trees from the previous stand, the infected residuals should be killed. In older infected stands, degree of infection should be determined (Hawksworth 1977), and thinning or partial cutting considered, for those stands not heavily infested. This will reduce infection levels and slow the decline in growth and vigor of the stand (van der Kamp and Hawksworth 1985).

Heavily infested stands approaching maturity, that have infected trees exceeding 8 inches d.b.h., should be partially cut to remove these beetle-attractive trees if sufficient growing stock remains for a reasonable yield at rotation. If growing stock would be insufficient, early replacement of the stand through regeneration harvest should be considered.

Wind and snow damage is common in immature lodgepole pine stands following thinnings or partial cuts, when the stand has been opened too much or extreme wind or snow has occurred. Wind damage can be minimized by adjusting thinning intensity to the exposure situation of the stand (Alexander and others 1983). Thinning adjacent to clearcuts where the prevailing wind angle approaches 90° should probably not exceed 40 percent of the basal area in a single entry (Schmidt and Barger 1987). Trees weakened by snow or wind damage are attractive to endemic mountain pine beetle and secondary bark beetles, and help mountain pine beetle populations survive at low levels and increase from those levels. Managers should pay close attention to heavily thinned stands, particularly those thinned from below, following heavy winds or snowfall. Obviously damaged trees should be removed promptly to deny them as breeding grounds for bark beetles, and to improve the general health and condition of the stand. Stands also can suffer unseen wind damage.

Trees that resisted wind-falling can suffer root damage from swaying and become attractive to bark beetles as a consequence (Christiansen and others 1987). Although such trees are difficult to detect until after-the-fact, bark beetles can detect them and focus attacks on them. Therefore, such stands, particularly those with size classes of lodgepole pine in or near them that are favorable for increasing mountain pine beetle populations, should be watched closely for several years following severe windstorms. Any trees colonized by bark beetles should be destroyed or removed from the stand before dispersal of broods from them.

In general, a forest-wide policy and program for stand improvement and sanitation of immature lodgepole pine stands will accomplish long-term benefits by reducing the number and severity of mountain pine beetle outbreaks. Mixed lodgepole pine stands, particularly those having a good representation of other species in the overstory, provide even more opportunities than pure stands for improvement cuts, for in them species discrimination against lodgepole pine can contribute to long-term reduction in mountain pine beetle hazard.

Manipulation of Stand Density, Composition, and Structure

The character and condition of immature stands can be greatly influenced by intermediate cuttings. Thinning appears to have the greatest potential for increasing or maintaining the vigor and growth of lodgepole pine trees and stands and thus contributing greatly to long-term prevention strategies for the mountain pine beetle (Cole and McGregor 1988). Both stocking control and intermediate thinnings are beneficial in this respect. Low thinning is the preferred thinning method for immature lodgepole pine, but the timing and spacing of thinnings to have a maximum effect on discouraging mountain pine beetle outbreaks are not yet clear. Early results from research studies (Mitchell and others 1983; Pitman and others 1982) and observations of operational thinnings in mountain pine beetle outbreak areas indicate that recently thinned older stands are passed over in the early stages of outbreaks, but might suffer some mortality in later stages when favorable host trees are depleted from surrounding unmanaged stands. Although larger trees in thinned areas still are vulnerable to epidemic mountain pine beetle populations, this does not disqualify thinning as a prevention practice.

Rather, the fact that even in outbreak situations thinned stands usually suffer a lower percentage of mortality of susceptible-sized trees, suggests that had thinning and other stand-tending practices been the norm rather than the exception the mountain pine beetle outbreaks might not have occurred (Cole 1978).

There is still debate as to whether the apparent benefit of thinning in reducing mortality from the mountain pine beetle is due to its effect on tree vigor or on the micro-environment influencing the beetle--or a combination of the two. Regardless of the exact and fundamental entomological explanation, thinning can be considered a valuable practice in long-term prevention silviculture for the mountain pine beetle problem. However, because too small a proportion of our lodgepole pine forests are likely to be thinned soon enough to fully succeed in prevention it is important that the fundamental effect of thinning on the mountain pine beetle be determined. Without this information, we do not know specifically how and when to thin or rethin stands approaching the mature stage. With this lack of knowledge we may delay mountain pine beetle outbreak by thinning, but set the stand up for even greater losses if the cause and duration of the thinning benefit are not thoroughly understood. With these uncertainties, what recommendations on type, intensity, and timing of thinnings, can be given for immature stands?

I believe the safest strategy at this time for pure immature lodgepole pine stands is to plan and execute an expanding program of thinning to accomplish stocking levels and growth rates that culminate and allow stand rotation at about 80 years of age (Cole 1975, 1978). The age, structure, and vigor of stands managed under this strategy are not considered to be highly susceptible to the mountain pine beetle (Amman 1978). When implemented on a forest-wide scale--with other factors (such as varied size and juxtaposition of stands) a richer forest mosaic can be created and hazard levels should be greatly reduced.

Another way of gaining diversity in the forest mosaic is through intermediate or repeated thinnings in older but still immature lodgepole pine stands. Culminated yields cannot be expected from such treatments at rotations of less than 120-140 years unless thinning intervals are 40 years or more (Cole and Edminster 1985). But it is questionable if such long thinning intervals can maintain tree and stand vigor at high enough levels to discourage mountain pine beetle outbreaks. Therefore, if low hazard is to be maintained in extended rotations, repeated light thinnings at 10-20 year intervals will probably be necessary, and less-than-culminated yields accepted at eventual rotation.

In mixed species stands, where there is a manageable alternative to lodgepole pine, diversity can be accomplished by manipulating species composition and stand structure in the course of thinning immature stands. Discrimination against lodgepole pine in these situations also allows for longer rotations than is safe with lodgepole pine, thus providing additional levels of an important factor for varying the forest mosaic.

In addition to reducing potential for future losses to the MPB, there are other opportunities and amenities that can result from thinning. Thinning patterns to enhance or achieve greater forest diversity can benefit other resource values and thus in many cases be largely justified by those objectives alone. As an example, thinning prescriptions can be designed to affect species composition and canopy development and modify hiding, thermal, and forage cover ratios important to wildlife. Water quality and yield are also important values justifying the creation of thinned stand patterns in high-elevation lodgepole pine forests.

Early Stand Replacement

Overall forest diversity can also be promoted by another practice applicable to immature stands--early stand replacement. Overstocked stands, or portions of them, can be clearcut for round-wood products and firewood or simply trampled and burned in place. Varying the timing and spatial arrangement of these treatments, in conjunction with species choices in the regeneration of the site, will help in attaining greater age class, stand size, and species diversity in our lodgepole pine forests. In the following section, the importance of planning in increasing immature stand and overall forest diversity is discussed.

PLANNING FOR INCREASED FOREST DIVERSITY

The scope and intensity of recent mountain pine beetle outbreaks show the difficulty of trying to prevent or limit the effects of outbreaks when there is a preponderance of mature and overmature stands--and when only a small proportion of the stands have benefitted from stand culture. Failure to use all opportunities to achieve an improved mosaic of age classes, species composition, and stand sizes of lodgepole pine stands in the next several decades will almost surely result in another cycle of serious losses to the mountain pine beetle. Otherwise-sound silvicultural prescriptions, determined on a stand-by-stand basis, will not greatly improve the situation unless they contribute to greater forest diversity. To accomplish that they must be determined in a much wider context than has usually been the case.

The good news is that several factors have evolved to the point where they facilitate and justify prevention prescriptions and programs that until recently were not feasible. Among these are: (1) the improvement in multiresource data bases, (2) the demand for a better balance in resource protection and productivities, (3) the widening public recognition that costs for prevention of resource losses are good investments, and (4) recent advances in computer-aided technologies. The data base and computer technology advances are especially significant: they provide breakthroughs in mapping land, forest cover, habitat, and stand types, and in analyzing phenomena planned or occurring therein. Known as geographical information systems (GIS), the more advanced of these systems are able to integrate a variety of map projection data formats with associated resource data bases to produce a huge array of analyst-chosen resource maps. Among the capabilities of these systems are several that have great value for planning and managing our forests for prevention of mountain pine beetle outbreaks:

- *The ability to identify locations meeting analyst-specified criteria.* Maps showing the scope and spatial distribution of all lodgepole pine stands--by land type, habitat type, successional role, and stand type--in a National Forest or region, would be an example of this.

- *The ability to assess impacts.* Effects wrought by the mountain pine beetle or programs designed to prevent mountain pine beetle effects can be evaluated visually and statistically. Information from a variety of sources--such as biological relationships, rules of thumb, expert opinion, management policy--can be combined in one or more steps to produce the desired impact estimates. The use of GIS to assess mountain pine beetle impacts on the Butte Ranger District of the Deerlodge National Forest, as described earlier in this symposium, demonstrates that this technology is already being brought to bear on the mountain pine beetle problem in the area of resource impacts.

- *The ability to preview and assess trade-off options.* Responding to mountain pine beetle epidemics or taking long-range steps to prevent them involves the balancing of impacts on different resource values. By providing spatial representations of different trade-off decisions for various future time periods, an optimum strategy for the criteria used can be identified.

- *The ability to integrate the above capabilities.* Advanced systems integrate their major features, thus solution values from each routine are available to the other routines to allow updating of management alternatives at chosen future time periods.

CONCLUSIONS

Taken together with our considerable ecological knowledge of host and pest, the exciting new capabilities in spatial analysis, and the increased public desire for reducing resource losses, it appears safe to say that we are on the threshold of a new era of forest-wide resource protection and management through silviculture. A good start in attaining desirable forest diversity has already occurred

through the cutting and regeneration patterns of the past 40 years--and now through a variety of intermediate and harvest cutting practices precipitated by recent MPB outbreaks, or the threat of them. Increased silvicultural management of immature stands can play a central role in reducing future resource losses caused by the mountain pine beetle.

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