Forest Practices Board Special Report

Lodgepole Pine Stand Structure 25 Years after Mountain Pine Beetle Attack

FPB/SR/32

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Board Commentary

An estimated area of 14 million hectares of pine forests will be attacked by mountain pine beetle (MPB) in BC by 2009. (Eng et al, 2004). Government and industry plan salvage harvesting of beetle-infested trees in much of the Central Interior, to extract as much timber value as possible before the wood deteriorates. In spite of the salvage efforts, large portions of infested area (some estimates are half of the affected forest) will not be commercially harvested. This is due to limited harvesting and milling capacity and economic, operational and ecological constraints. In addition, beetle-attacked areas in provincial parks, or outside the timber harvesting landbase, will not be harvested or replanted.

British Columbia's Mountain Pine Beetle Strategy[1] advocates active restoration of forests in MPB-attack areas. Government may use silviculture treatments such as site preparation, planting, and brushing to ensure timely restocking of unsalvaged stands. The Ministry of Forest and Range's Forests for Tomorrow program will invest $86 million dollars over the next 5 years in reforestation of beetle–killed and burned areas. However, constraints may limit the widespread use of these treatments and many stands may be left to regenerate on their own.

Communities in the central interior are concerned about the appearance of the landscape after the beetle attack and harvesting are over; about the implications for watersheds, wildlife and tourism in large salvage clearcuts; and about fire hazards if dead pine forests are simply left standing. Forest management planning requires an understanding of the long-term characteristics of unsalvaged forests.

The current MPB attack, which began in 1995, is unprecedented in area. There have been previous large attacks however – most recently, the 1979 MPB attack in the Chilcotin and southern Quesnel Districts. While most of these stands were salvage harvested, there are remnant areas that were never harvested. These residual stands have developed unique structural and vegetative characteristics. There is a remarkable tree growth release and regeneration. Lodgepole pine regeneration under the forest canopy has led to a multi-age and multi-size stand structure. Stocking density on some of these sites exceeds the target stocking for lodgepole pine clearcuts. The mix of understory and overstory trees, the standing and downed coarse woody debris, and the vigorous understory plants

[1] http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/actionplan/2006/Beetle_Action_Plan.pdf

have created a diverse plant community with significant structure. This is a positive result for recovery of the forest and its associated values.

The Board is not making general recommendations on the reforestation of MPB-attacked stands. One of the limitations of this study is that the results are from sites in only the Sub Boreal Pine Spruce and Montane Spruce biogeoclimatic zones. The current MPB outbreak in BC has mainly occurred in the moister biogeoclimatic zones and has a more even aged stand structure (see Coates, 2006). Nevertheless, the observations are significant. Even in these more severe tree growth conditions – 25 years post-beetle attack –these sites are not a biological desert. In fact, they may provide more wildlife habitat than a mature lodgepole pine forest or a stand regenerating after clearcut or fire. These stands also provide an intermediate level of hydrological benefit, compared to clearcutting, buffering watersheds against peak flow effects. In time, these stands will also provide timber; however, it is unlikely that these specific sites will provide the same timber volumes that a clearcut/plant regime will over 80-years.

Foresters should carefully manage unsalvaged MPB-attacked stands. These stands will contribute significantly to future timber supplies, hydrological recovery, wildlife habitat and visual quality. A designed forest should integrate the ecological, social and timber benefits of residual non-pine stands, clearcut and regenerated stands, and areas of forest that were attacked by mountain pine beetle. This is consistent with recent advice of the Chief Forester on the need for complexity and resilience in our forests.

Acknowledgements

Steve Chatwin and Bryce Bancroft carried out the field investigation and described the stand characteristics of the sites in this report. All photos are by Chatwin and Bancroft.

Objectives

This report describes the characteristics of pine stands attacked by mountain pine beetle (MPB) in 1979. The objective is to report the mortality, "secondary structure" (seedlings, saplings and sub-canopy trees that survived the pine beetle attack), growth following release, and new regeneration, for stands attacked by mountain pine beetle 26 years ago. The rationale is that stands currently attacked by the mountain pine beetle might also develop along similar pathways.

This work complements a more extensive MOFR survey of stand characteristics from the current epidemic (Coates et al. 2006), but it also adds the dimension of a longer-term perspective (26 years post-attack). A similar project has described stand characteristics in a range of old MPB infested sites in the Chilcotin Forest District (Hawkes et al, 2004).

Location

Board staff examined stands attacked in the 1979 beetle attack in the Wentworth landscape unit, Quesnel forest district (Figure 1) The Wentworth landscape unit is in the southwest part of the district. The area sampled was in the Sub-Boreal Pine Spruce biogeoclimatic units (SBPSxc, SBPSmk and SBPSdc). The Coates (2006) study did not sample those BEC units.

Location of Sample Sites

Figure 1. Location of the vegetation survey

Methods

Staff identified stands killed by the mountain pine beetle in 1979 by overlaying cutblock locations, mapped in the silviculture database (RESULTS), on the 1980 forest cover map. In the Wentworth landscape unit, the forest cover polygons have an attribute field indicating the intensity of the 1979 beetle attack. (Figure 2). District staff had field-verified the beetle intensity information at the time of the survey, so the data is quite reliable.

A 1980 detailed aerial survey map of the mountain pine beetle attack was overlain on a Landsat image as a secondary source of information. It showed which MPB affected areas had been harvested and which had been left, but this source was less reliable than the first method described above.

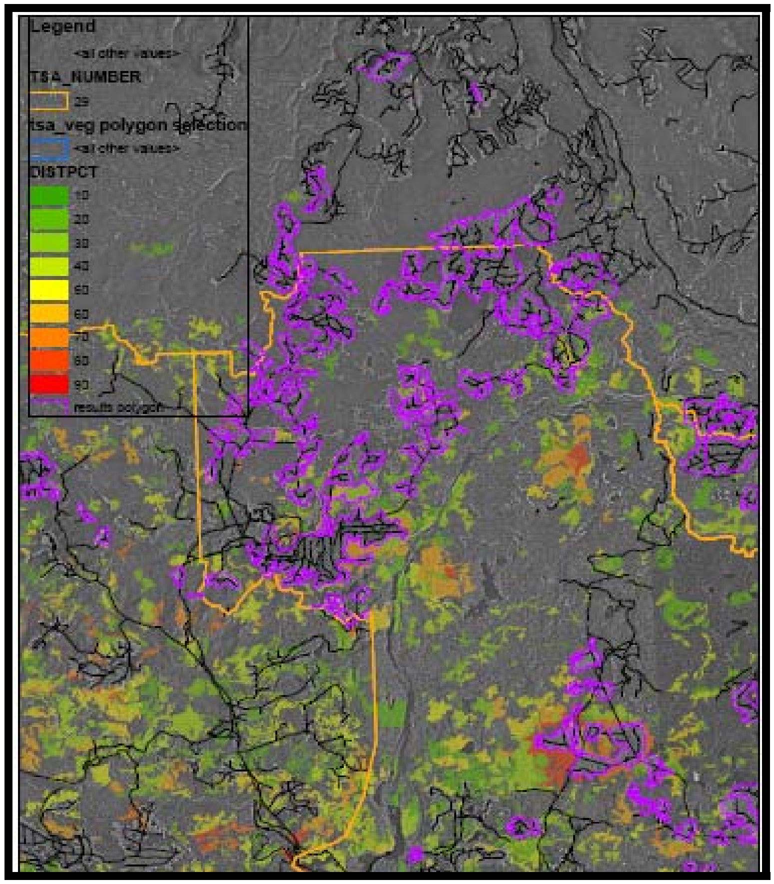

Figure 2. Intensity of MPB attack from the forest cover layer

Staff used the two map sources to identify those forest polygons that had been beetle attacked and remained unharvested. The 1980 salvage program was very thorough, so there were only 15 sites in the landscape unit that met the criteria of 1) representative of the overall forest cover 2) at least 80% attacked, and 3) not harvested. Staff visited all of these sites in this study. Staff took notes on the ground cover and the stand description, including species composition, the amount of dead pine, understory regeneration species, density and levels of coarse woody debris.

Observations

1. Understory Species Composition

All of the sites had dry to mesic moisture regimes. The vegetation was dominated by kinnikinnick (*Arctostaphylos uva-ursi*) which was found on all sample sites and averaged 46% cover. Common juniper (*Juniperus communis*) occurred on all but one of the sites, averaging 10% cover. Grey reindeer lichen (*Cladina rangiferina*) was on 79% of the sites, averaging 8% cover. Pinegrass

(*Calamagrostis rubescens*) and soopolallie (*Shepherdia Canadensis*) were on 64% of the sites, averaging 22% and 7% cover respectively. Other species occurred but were less consistent and had lower cover values. These values fit well with many of the drier ecosystem vegetation table results for the BEC units evaluated (Steen and Coupe, 1997).

Figure 3 Typical understory of kinnikinnick, common juniper, pinegrass and lichen

Processes

The dynamics of both live and dead trees following a mountain pine beetle attack are important to future stand condition. The processes affecting the stand characteristics include mortality of host trees; breakage; falldown and decomposition; and growth of residual trees and regeneration of new seedlings. Mortality was almost exclusively due to a combination of the 1979 MPB attack, which killed 70% of the mature pine, and the 2005 attack, which killed 60% the remaining mature pine. The combined average mortality was about 85%. Post-attack windthrow appeared to be a significant process in only two sites.

Longevity of Standing Stems

Figure 4. Percentage of old dead trees still standing 25 years after infestation.

Staff estimated standing dead by counting standing and downed old dead trees over plots of 0.1 ha within the infestation area. The proportion still standing varied from 0 to 80% after 25 years with an average of approximately 45% standing (figure 4), Figure 5 shows a typical site with 50% standing old dead. (The red trees in this photo are the result of the current epidemic in the area.)

Figure 5. A mix of old dead standing pine (approximately 50%), old dead down pine, recent dead pine, and living spruce.

Secondary Structure and Regeneration

Coates et al (2006) defined secondary structure as the seedlings, saplings, sub-canopy and canopy trees that survived the pine beetle attack. The MPB mortality on these sites has created a unique lodgepole pine multi-age and multi-size stand structure. Pine is the main conifer species (over 90%) found in the understory.

Regeneration on these sites is patchy with dense clumps in some areas and relatively open portions elsewhere. The range of regeneration plus residuals varied from none to over 4000 stems per hectare (sph). The average total sph in areas with regeneration was 1600. Coates (2006) has suggested that 1000 stems/ha is a stocking level that should result in full site occupancy. Approximately one third of the samples met this threshold and appear to have 'good' or thrifty new regeneration. This compares with Coates' findings, in the dry cold variants of his study (SBSdk), where the understory trees were the least common and only 20% of the plots exceeded 1000 sph.

Coates and Hall (2005) established a target, on more mesic sites, of 5-10 m2/ha of secondary structure as sufficient to contribute to mid-term timber supply. On our drier sites, a target of 4-7 m2/ha is more realistic. In our sites, only 5 of the 15 sites (30%) exceed this, similar to what Coates found in recently killed stands in the SBSdk.

It was not always obvious if pine seedlings were residuals or post-attack regeneration. Where it could be identified, pine regeneration that came in after the infestation was more healthy and growing faster than the advance residual pine that was in the understory at the time of the infestation (see Figure 10). This was especially the case where residual pine was infected with dwarf mistletoe. Fir and spruce seedlings occur on about one-third of the sites and, where established grew well, with leaders up to 35 cm.

Release of Surviving Trees

Survival rates of mature pine ranged from 10 to 50% for the areas sampled. Most overstory trees that survived the infestation grew in diameter significantly faster after the epidemic than before it. Ten of the 14 sampled trees showed a significant growth response. The range of response varied from 1.0 to 3 times the radial growth during the last 25 years when compared to the 25 previous years (Figure 6). The average increase was approximately 44% greater than the pre-infestation growth rate.

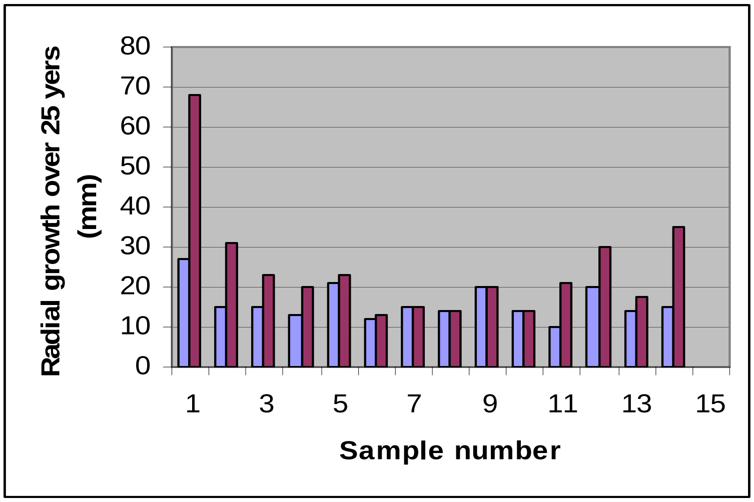

Figure 6: Release of surviving overstory pine trees following 1979 MPB attack. Graph shows radial growth over 25 years pre-attack (blue) and post attack (red).

Figure 7a): The photo shows radial growth of approximately 70mm for the last 25 years with approximately 40mm for the previous 25 years.

Figure 7b): Photo shows 30 mm for the last 25 years of radial growth with 10 mm for the previous 25 years.

Figure 8: Photo shows a small opening created by the 1981 infestation where young pine is becoming established. Typical ingress densities exceed 1000 sph on these drier sites. The range of top heights, 25 years post infestation, was from 30 cm to 4 meters.

Figure 9a): Photo shows an area of little natural ingress in the foreground, with clumps noticeable in the background.

Figure 9b): Photo shows most of the overstory on this exposed ridge is now down, yet regeneration is patchy, much of which was advance regeneration that has not released.

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Advance pine regeneration with dwarf mistletoe.

Figure 10: Photo shows two pines from the same site. The one on the left is approximately 20 years old and 2 m tall; the tree on the right is approximately 90 years old and 1.3 m tall. The tree on the right has been affected by dwarf mistletoe (inset). This shows clearly the difference in growth potential of new healthy stems versus infected advance regeneration). Spruce and fir established if there is a seed source, often at relatively low densities (i.e., 50 - 400 sph). Once established, they were growing well.

Figure 11: Fir and pine regeneration, Pine at approximately 800 good sph, 400 poor, and fir with 400 good sph (35 cm leader).

Coarse Woody Debris

Many (45%) of the dead pine were still standing. About half of the fallen trees had intact root wads indicating that they were wind thrown, while the other half rotted at the ground level, like a fence post, resulting in the tree falling down.

Eleven coarse woody debris transects (2 x 15m) were tabulated using the CWD/Fuel Calculator[2] . The results show a range of volumes of CWD from 32 to 166 m^3/ha, with an average of 106 m3/ha.

Figure 12a): A windthrown stem.

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Figure 12b): Photo shows rot at the root collar

[2] Ember Research Services Ltd. 1997. CWD/Fuel Calculator Program, Victoria BC. Available from the Research Branch MoFR.

Wood Quality

Staff did not formally assess wood quality during this survey. However, a number of old dead trees were drilled. Trees that lay on the ground showed significant amounts of decomposition. The bulk of the volume remained, apparently sound, on standing trees and those elevated above the ground; however, they commonly had heart rot. In all cases, the dead pine showed evidence of severe surface checking (cracks).

Figure 13: Standing wood is checked. Some of the trees remained sound; others were rotten at the surface.

Comments on Hydrological Recovery

Hydrological recovery in disturbed sites is a function of the crown closure, height and crown volume of the residual and regenerated forest (Winkler and Roach, 2005). The sites in this study have approximately a 25 % crown closure. Half of the original dead stems are still standing, regeneration is patchy and top heights ranged from 30 cm to 4 meters. Based on comparisons with rates of hydrological recovery in Interior snow research stands, we roughly estimate the Equivalent Clearcut Area (ECA) of these sites to be about 30%.[3]

Our ECA estimates, when compared to those in recently MPB-killed stands (Beaudry 2006), mean that the ECA of these sites essentially did not change much over the past 25 years. This may be due to the opposing processes of stand opening (due to fall-down of mature trees) and stand closure (due to regeneration and release of residuals.)

[3] Hydrological recovery is often expressed as (ECA), where 0% ECA is a fully recovered stand and 100% ECA is a clearcut

Conclusions

The 1979 unharvested MPB-attacked pine stands developed a unique multi-age and size stand structure due to the ability of lodgepole pine to regenerate under the forest canopy. This structure has considerable habitat value because it includes elements of standing wood and fallen dead trees, remnant overstory trees, and vigorous understory. The understory vegetation mosaic appeared healthy and well-established, building upon what was there before the infestation. These stands may provide more diverse wildlife habitat than a mature lodgepole pine forest or a stand regenerating after clearcut or fire. There would be little reason for intervening in these stands if habitat restoration was the goal.

Regarding immediate timber supply objectives, approximately half of the MPB-attacked trees are still standing and are often still sound but checked. That suggests that the shelf life for fibre-based, non-lumber products in these dry, cold ecosystems may be 20 years or more. These drier sites also have relatively low levels of total downed wood and are not a significant fire hazard.

Regarding future timber supply, there was significant diameter growth increase (release) on most residual stems; however, the standing live volume was still significantly lower than volumes on comparable sites that were not attacked. Only 30% of the sites met the target of secondary structure sufficient to contribute to mid-term timber supply. Approximately one third of the sites are stocked, without any further silvicultural intervention. It is unlikely that these sites will provide sufficient timber volumes in an 80-year rotation. Salvage harvesting and reforestation, or possibly underplanting is needed where timber supply is the goal and full site occupancy is the objective.

The observations made in this study are mainly applicable to the SubBoreal Pine Spruce biogeoclimatic subzones. The current MPB outbreak in BC has largely occurred in the moister biogeoclimatic zones with a more even-aged stand structure (see Coates, 2006).

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NEWS RELEASE

For Immediate Release
January 23, 2007

Beetle-Killed Trees Have Environmental and Timber Value

VICTORIA – Stands of trees killed by the mountain pine beetle still provide environmental benefits and potential timber value if left standing, according to a Forest Practices Board special report released today.

The report examined pine stands affected by the 1979 mountain pine beetle attack in the southern Quesnel forest district. Trees left standing or regrown since that outbreak have developed unique structural features that now provide valuable wildlife habitat, 26 years after the original beetle attack. The board found that those trees that survived the pine beetle attack grew faster than prior to the attack, and may represent a source of mid-term timber supply.

“As B.C. grapples with the current mountain pine beetle epidemic, our work suggests the economic rationale for rapid salvage logging should be balanced with the benefits of retention of infested trees to enhance forest diversity and protect environmental values,” said board chair Bruce Fraser. “This is consistent with the recent advice of the Chief Forester for designating larger areas for retention in beetle-infested pine stands.”

It should be noted the area studied is in a cool, dry climate zone in the Interior of the province. The Ministry of Forests and Range is conducting further studies to determine if the results are valid for the moister climate zones, which are the focus of the current mountain pine beetle epidemic.

The Forest Practices Board is B.C.’s independent watchdog for sound forest and range practices, reporting its findings and recommendations directly to the public and government. The board:

- audits forest and range practices on public lands;
- audits appropriateness of government enforcement;
- investigates public complaints;
- undertakes special investigations of current forestry issues;
- participates in administrative appeals; and
- makes recommendations for improvement to practices and legislation.

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Lodgepole Pine Stand Structure 25 Years after Mountain Pine Beetle Attack

This report describes the characteristics of pine stands attacked by mountain pine beetle in 1979, reporting on mortality, “secondary structure” (seedlings, saplings and sub-canopy trees that survived the pine beetle attack), growth following release, and new regeneration in an effort to predict how non-salvaged stands currently attacked by MPB, might develop.

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