Species Composition and Regeneration in Cutblocks in Mountain Pine Beetle Areas

Special Investigation

FPB/SIR/15

October 2006

Acknowledgements

The Board acknowledges the work of Steve Chatwin, Bryce Bancroft and Mei-Ching Tsoi in preparing this report. Pat Martin provided valuable review comments.

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Glossary

Deciduous: Trees, such as aspen which are normally leafless for some time during the year.

Ecologically suitable species: Coniferous or deciduous tree species that are naturally adapted to a site's environmental conditions.

Even-aged stand: A stand of trees consisting of one or two age classes. Even-aged stands are often the result of fire, or a harvesting method such as clearcutting or shelterwood.

Fill-in planting: Planting required to supplement poorly stocked natural regeneration.

Forest cover type: A term used to group stands of similar characteristics and species composition.

Mixed-pine: Stands with less than 80 percent pine and more than 20 percent other tree species.

Mono pine: Stands with more than 80 percent pine.

Natural regeneration: The renewal of a forest stand by natural seeding, sprouting, and suckering.

Not satisfactorily restocked (NSR): Productive forest land that has been denuded and has failed, partially or completely, to regenerate either naturally, or by planting or seeding, to the specified or desired free-growing standards for the site.

Pine-leading: Pine is the dominant tree species in the stand.

Regeneration: The renewal of a tree crop through either natural means (seeded on-site from adjacent stands or deposited by wind, birds, or animals) or artificial means (by planting seedlings or direct seeding).

Regeneration delay: The maximum time allowed in a prescription, between the start of harvesting in the area to which the prescription applies, and the earliest date by which the prescription requires a minimum number of acceptable well-spaced trees per hectare to be growing in that area.

Regeneration date: The date by which the minimum number of healthy well-spaced trees must be established and subsequently maintained until the stand is declared free-growing.

Regeneration survey: Carried out to determine the initial restocking of a site.

Species composition: The percentage of each recognized tree species comprising the forest type based upon the gross volume, and the relative number of stems per hectare or basal area.

Stand: A community of trees sufficiently uniform in species composition, age, arrangement, and condition to be distinguishable as a group from the forest or other growth on the adjoining area, thus forming a silviculture or management entity.

Stand conversion: Changing the species composition of a stand to more desirable tree species that are less susceptible to damage or mortality from certain insects or diseases.

Standards unit: A portion of a cutblock (with similar soil and moisture conditions) with similar density and species requirements.

Stocking: A measure of the area occupied by trees, usually measured in terms of well-spaced trees per hectare, or basal area per hectare, relative to an optimum or desired level.

Executive Summary

British Columbia is currently in the midst of a massive outbreak of mountain pine beetle (MPB). The extent of the outbreak poses unprecedented challenges for forest development and reforestation. To address the infestation, annual cut levels have been raised to salvage the wood value before it deteriorates. Large cutblocks and rapid rates of cut consequently demand a high level of reforestation effort to keep up to the harvest rates.

There is some public concern about whether we are able to keep up with reforesting such large areas of beetle harvesting, and what species are being regenerated on these sites. As a result, the Board decided to look at regeneration in beetle harvest areas and compare what's happening to similar areas that are not greatly affected by the pine beetle epidemic.

The report assesses reforestation, over time, in the three districts (Quesnel, Vanderhoof and Nadina) most heavily affected by the MPB epidemic (MPB-districts). It compares this performance with the reforestation efforts in the districts that are pine-leading, but have not yet been as severely affected by the beetle epidemic (low-MPB-districts).

This report answers the questions:

1. Are harvested areas being regenerated promptly?
2. Do the planted species differ from the original forest?
3. Is only lodgepole pine being re-planted?

Regeneration, mainly by planting, of cutblocks following harvest in MPB-districts was well within the prescribed regeneration window. The timeliness of planting is slightly more punctual in the MPB-districts than in low-MPB-districts. The percent of harvested area that is planted is also similar in MPB and low-MPB areas.

For the 1995-2000 time period, when the MPB attack was beginning, lodgepole pine remained the most common species for planting in MPB areas. Planting with pine or mixed-pine in previously pine-dominated stands was the norm. Thirteen percent more area was planted to mono-pine (greater than 80 percent pine) than existed prior to harvesting. However, for the 2000-2004 period there were equal areas of mono-pine planted and harvested. Natural regeneration, as well as tree retention during harvest, may also ensure some level of species diversity in the cutblocks. Uptake of mixed-species planting has been slower in low-MPB districts, where there has been a net increase of 10% more area in mono-pine in the 2000-2004 period.

For all interior districts combined, there has been an increase of 6% in area planted with mono-pine compared to areas of harvested mono-pine during the period 1995-2004. The total area of pine-leading (mono + mixed), for all interior districts combined, has remained relatively constant , at 53%, pre-harvest and post-harvest, from 1995-2004.

The main issues for reforestation of MPB-attacked areas are: i) species diversity and mixed-species planting; and ii) active management of landscape- and forest-scale young stand species composition.

Board Commentary

The reforestation of areas impacted by MPB is important to a host of stakeholders and communities in the interior of BC. This investigation has found that reforestation in MPB affected districts is at least as prompt, or quicker, than in districts not affected by MPB. This achievement is a credit to the licensees managing these areas.

The species composition of the new forest will be one of the major factors in the risk of timber shortfalls in the face of future outbreaks. Lodgepole pine remains the best, and only, species option in many instances. However with site preparation, vegetation management, and vigorous stock, species such as Douglas-fir and spruce can be established on more sites.

The investigation found that there has been a small increase in the percentage of area being reforested with mixed species planting, as opposed to pure pine plantations, over the past five years in MPB impacted districts. Again, the Board views this as a positive trend.

This shift to more mixed species planting occurred through decisions made by individual licensee foresters. This trend would likely increase if supported by a provincial strategy to increase species diversity where feasible. At the present time, there is no provincial direction, in terms of species selection guidelines, or letters from the chief forester or district managers, indicating their desire for more species diversity. Nor is there any analytical tool at present to enable monitoring of species diversity over multiple cutblocks or landscape units.

As broad scale areas of salvage logging grow over the next few years in areas impacted by MPB, it is essential that the Ministry of Forests and Range support long term forest resilience by consulting with those responsible for reforestation and providing strategic direction and monitoring tools for achieving species diversity.

Introduction

British Columbia is currently in the midst of a massive outbreak of mountain pine beetle (MPB). The extent of the outbreak poses unprecedented challenges for forest development and reforestation. The Board is examining a number of different issues related to harvesting of areas attacked by the MPB, and will be releasing a series of reports on different aspects of the MPB harvesting operations. This report reviews the reforestation of areas that were harvested following MPB.

Forests of mature lodgepole pine are prime habitat for the MPB. The beetle also thrives under warm weather conditions. The interior of BC has an abundance of mature lodgepole pine, and has experienced several consecutive mild winters and drought-like summers. Beetle populations in many parts of interior BC have increased to epidemic levels as a result.

MPB preferentially attack mature pine trees over 40 years of age. Unlike past epidemics, the current infestation is also found in young age classes, where stands as young as 20 years have sustained high levels of attack.

The current outbreak started in 1994 and has steadily progressed to now cover 50 percent of pine-dominated stands in the province, a total infestation area of 8.5 million hectares. The most severely affected forest districts are Quesnel, Nadina and Vanderhoof. The Quesnel Forest District, for example has 73 percent of stands with some level of MPB mortality, and nearly 100 percent of stands over 31 years old have been attacked.[1] The risk to young stands is declining in the core area of the outbreak, but the highest future risk may be in the southern districts as the beetle runs out of mature host material.

To address the infestation, annual cut levels have been raised to salvage the wood value before it deteriorates. For example, in the Quesnel Forest District, there has been an increase in annual allowable cut of 1.5 million cubic metres. Large cutblocks and rapid rates of cut consequently demand a high level of reforestation to keep up to the harvest rates.

[1] Maclauchlan, Lorraine, *Status of Mountain Pine Beetle Attack in Young Lodgepole Pine Stands in Central British Columbia*, report prepared for the Chief Forester, Jim Snetsinger, January 23, 2006.

Fortunately, British Columbia is a world leader in reforestation of logged areas. Previous reports by the Board have documented a high success rate in achieving reforestation objectives across the province.[2]

Areas harvested following a mountain pine beetle infestation must still be reforested by the licensee; however, reforestation poses some unique challenges. With up to 80 percent mortality of mature pine, the future forest economy will be dependant on the second growth crop now being planted. Nearly two million hectares of young pine have been regenerated (planted and natural) in BC and more than 1.1 million hectares of that are single species plantations. Species composition of young stands is a key determinant of the forest's future productivity, value, and health. If the species being regenerated is pine, are we re-creating conditions ideal for another beetle outbreak 70 or so years from now? By careful management and control of species composition during reforestation can we reduce the risk of catastrophic timber losses in the future?

There is some public concern about whether we are able to keep up with reforesting such large areas of beetle harvesting, and what tree species are being regenerated on these sites. As a result, the Board decided to look at regeneration in beetle harvest areas and compare what's happening there to similar areas that are not greatly affected by the massive pine beetle epidemic.

Background

Reforestation following harvest has been a forest licensee obligation since 1987. While the regulations have been modified and renamed over the years, the intent remains basically the same. A minimum number of trees per area, which are suited to the site, are required to be established within a specified time frame. In BC, this is typically achieved by planting seedlings. The maximum length of time for reforestation is referred to as regeneration delay. As forestry law has evolved since 1987, regeneration delay has been specified in various operational plans: preharvest silviculture prescriptions (1987-1994 under the *Silviculture Regulation*), silviculture prescriptions (1995-2004 under the Forest Practices Code), forest development plans (as of December 2002), and now forest stewardship plans (under the *Forest and Range Practices Act* (FRPA)).

Reforestation standards apply to individual harvested areas, and the reforestation of each harvested area is managed independently. As a result, the species composition of the young age class in a forest emerges from the species selections made by multiple foresters, each acting independently as they work to restock individual cutblocks. There are no requirements for, and few examples of, co-coordinating the reforestation of cutblocks to achieve a desired cumulative outcome for forest- or landscape-scale composition.[3]

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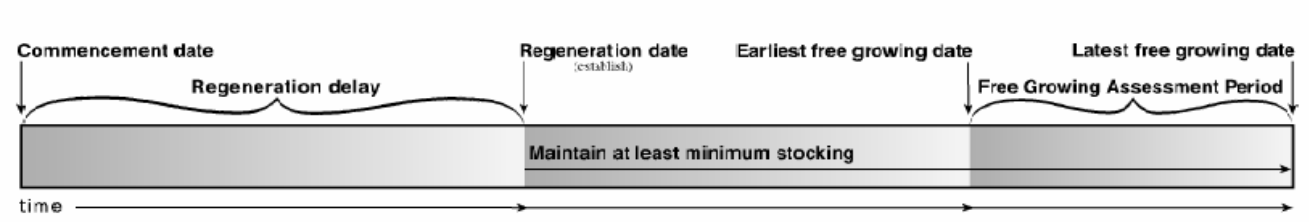
[2] *Reforesting BC's Public Land – An Evaluation of Free-Growing Success Special Report*, Forest Practices Board, 2003; *Achievement of Free-Growing Forests – 2004 Provincial Update Special Report*, Forest Practices Board, 2006.

[3] For example, see the Board's 2004 report "*Evaluating Mountain Pine Beetle Management in British Columbia*." For two landscape units in the Nadina Forest District, the Board noted that there was no reforestation planning at the landscape level.

Regeneration is considered to have been met either right after planting or upon completion of a survey within the regeneration delay period. In either case, the number of well-spaced trees must exceed the minimum standard prescribed for each harvested area (known as a standards unit). In the past, the regeneration date occurred two to seven years after the commencement of harvest for most interior ecosystems.

All pine harvest areas, including mountain pine beetle salvage areas, have the same legal regeneration obligations as any other harvest areas in BC. One exception is those areas harvested under small scale salvage or other minor licences, such as a licence to cut, where areas smaller than one hectare are exempt from regeneration requirements.



Key dates in regeneration timeline.

Objectives

The objectives of this report are to examine areas where there has been a significant amount of harvesting directed at control of the mountain pine beetle epidemic, or where there has been salvage of wood that was attacked by the beetle:

1. To determine if those areas are meeting regeneration targets.
2. To determine if those harvested areas are reforested to desirable species compositions.

Previous reports by the Board[4] have demonstrated that regeneration targets are being met across the province. The method used in this report isolates the mountain pine beetle affected districts and compares the regeneration results with the rest of the interior districts.

The hypothesis, for testing, is that the reforestation in mountain pine beetle affected areas is managed in the same manner as those areas that are not significantly affected by mountain pine beetle.

[4] *Reforesting BC's Public Land – An Evaluation of Free-Growing Success Special Report*, Forest Practices Board, 2003; *Achievement of Free-Growing Forests – 2004 Provincial Update Special Report*, Forest Practices Board, 2006.

Scope

The areas of interest are the three forest districts most impacted by mountain pine beetle attack:

- Quesnel Forest District, which coincides with the Quesnel Timber Supply Area (TSA)
- Nadina Forest District, which contains the Lakes TSA and the Morice TSA
- Vanderhoof Forest District, which is a portion of the extensive Prince George TSA

Regeneration delay was assessed in these districts for all openings that were harvested between March 31, 1995, and March 31, 2000, with a regeneration date prior to April 1, 2004.

Species selection in openings was assessed over two time periods:

1. logged between March 31, 1995, and March 31, 2000, and planted before April 1, 2004.
2. logged between March 31, 2000, and March 31, 2004, and planted before April 1, 2004.

The sample set included the main forest tenure types (major licensees, woodlot licensees, and BC Timber Sales). It did not include backlog silviculture prescriptions or small scale salvage, as this information was not available in the Reporting Silviculture Updates and Land Status database (RESULTS).

Methods

The provincial database housed in RESULTS was used to extract information regarding achievement of regeneration delay. The data used to assess regeneration date[5] was taken from forest cover submissions, which is a mandatory field in RESULTS. In this report, regeneration delay equals the date of forest cover submission minus the date of harvest completion.

The database was spatially sorted into two groups:

1. MPB-districts: Districts where there has been a significant amount of harvesting directed at the mountain pine beetle epidemic or salvage of stands affected by the beetle (Nadina, Quesnel and Vanderhoof).
2. low-MPB-districts: All other interior districts with pine, but less significantly affected by the MPB epidemic (see Table 1).

[5] While there is also a milestone declaration that can be made for regeneration date, it is not mandatory, and therefore does not provide reliable information when queried.

All stands were categorized as being pine-leading or not-pine-leading. The total number of eligible records used for this analysis was 363,400 hectares, of which 75,800 were in the MPB-districts, and 287,600 were in the low-MPB-districts.

Trends were assessed by dividing the dataset for the MPB-districts into two time periods:

1. Cutblocks harvested between March 31, 1995, and March 31, 2000. This represents the population of cutblocks in the MPB-districts when the beetle epidemic was starting to build.
2. Cutblocks harvested between March 31, 2000 and March 31, 2004 and planted. This represents the population of cutblocks in MPB-districts in the midst of the MPB attack.

Results

1. Achieving Regeneration

Cutblocks harvested 1995-2000

The first objective was to determine if cutblocks harvested in the MPB-districts:

- achieved regeneration within the required timing window; and
- were regenerated as promptly as in the low-MPB-districts.

Table 1 provides a list, by district, of the stocking status of all blocks harvested between March 31, 1995, and March 31, 2000. (Cutblocks harvested after this date have not yet reached the typical regeneration due date). The cutblocks were divided into immature (IMM), meaning planted or naturally regenerated stock, and not satisfactorily restocked (NSR) classes, meaning the cutblock has not been planted and has not regenerated naturally. The data are presented in three sub-groups based on the stand label prior to harvest: 1) non-pine-leading stands; 2) pine-leading; and 3) the total of both.

There is no difference in the level of NSR between the MPB-districts and low-MPB-districts in the pine-leading category (2 percent in both cases, Table 1). In non-pine-leading stands, the level of NSR is lower in MPB-districts than in low-MPB districts (1 percent versus 3 percent). Further, with the aggregate of the species, the total NSR is lower in the MPB-districts when compared with the other low-MPB-districts (3 percent versus 5 percent).

The level of regeneration in cutblocks is equal in pine-leading areas in the MPB-districts as compared to the low-MPB-districts.

Table 1: Current Forest Cover Stocking Status of Areas Logged Between April 1, 1995, and March 31, 2000, Regeneration Due Prior to April 1, 2004, with Previous Stand Label Leading Species by District (Data source: RESULTS June 05, 2005)

All File Types

MPBDist	District Name	Non Pine			Pine			Combined		
		IMM	NSR	Total	IMM	NSR	Total	IMM	NSR	Total
		proportion								
MPB	Nadina Forest District	33%	0%	34%	64%	3%	66%	97%	3%	100%
MPB	Quesnel Forest District	27%	0%	28%	70%	2%	72%	97%	3%	100%
MPB	Vanderhoof Forest District	9%	1%	10%	87%	3%	90%	96%	4%	100%
MPB Districts Total		**26%**	**1%**	**27%**	**71%**	**2%**	**73%**	**97%**	**3%**	**100%**
NonMPB	100 Mile House Forest District	26%	1%	27%	71%	2%	73%	97%	3%	100%
NonMPB	Arrow Boundary Forest District	73%	1%	74%	26%	1%	26%	98%	2%	100%
NonMPB	Cascades Forest District	39%	1%	41%	58%	2%	59%	97%	3%	100%
NonMPB	Central Cariboo Forest District	53%	1%	54%	44%	2%	46%	97%	3%	100%
NonMPB	Chilcotin Forest District	5%	0%	5%	93%	1%	95%	99%	1%	100%
NonMPB	Columbia Forest District	88%	0%	88%	12%	0%	12%	100%	0%	100%
NonMPB	Fort Nelson Forest District	86%	6%	92%	8%	0%	8%	94%	6%	100%
NonMPB	Fort St. James Forest District	40%	0%	40%	60%	0%	60%	100%	0%	100%
NonMPB	Headwaters Forest District	83%	6%	88%	11%	1%	12%	94%	6%	100%
NonMPB	Kalum Forest District	97%	2%	100%	0%	0%	0%	98%	2%	100%
NonMPB	Kamloops Forest District	39%	6%	45%	52%	3%	55%	91%	9%	100%
NonMPB	Kootenay Lake Forest District	71%	1%	72%	26%	2%	28%	97%	3%	100%
NonMPB	MacKenzie Forest District	50%	5%	55%	40%	5%	45%	90%	10%	100%
NonMPB	Okanagan Shuswap Forest District	56%	3%	60%	39%	2%	40%	95%	5%	100%
NonMPB	Peace Forest District	59%	2%	61%	39%	0%	39%	98%	2%	100%
NonMPB	Prince George Forest District	49%	2%	52%	46%	3%	48%	95%	5%	100%
NonMPB	Rocky Mountain Forest District	53%	3%	57%	42%	1%	43%	95%	5%	100%
NonMPB	Skeena Stikine Forest District	77%	6%	83%	15%	1%	17%	93%	7%	100%
Non MPB Total		**60%**	**3%**	**63%**	**36%**	**2%**	**37%**	**95%**	**5%**	**100%**

2. Timing of Regeneration

Cutblocks harvested between 1995 and 2000

Prompt reforestation is—or should logically be—an objective for cutblocks in areas affected by the MPB epidemic. Regeneration timing was examined for cutblocks logged between 1995 and 2000, and that had been declared as regenerated, in the MPB-districts and in the low-MPB-districts. All of these cutblocks have a regeneration date specified in the silviculture prescription, which is the latest date by which regeneration must be achieved.

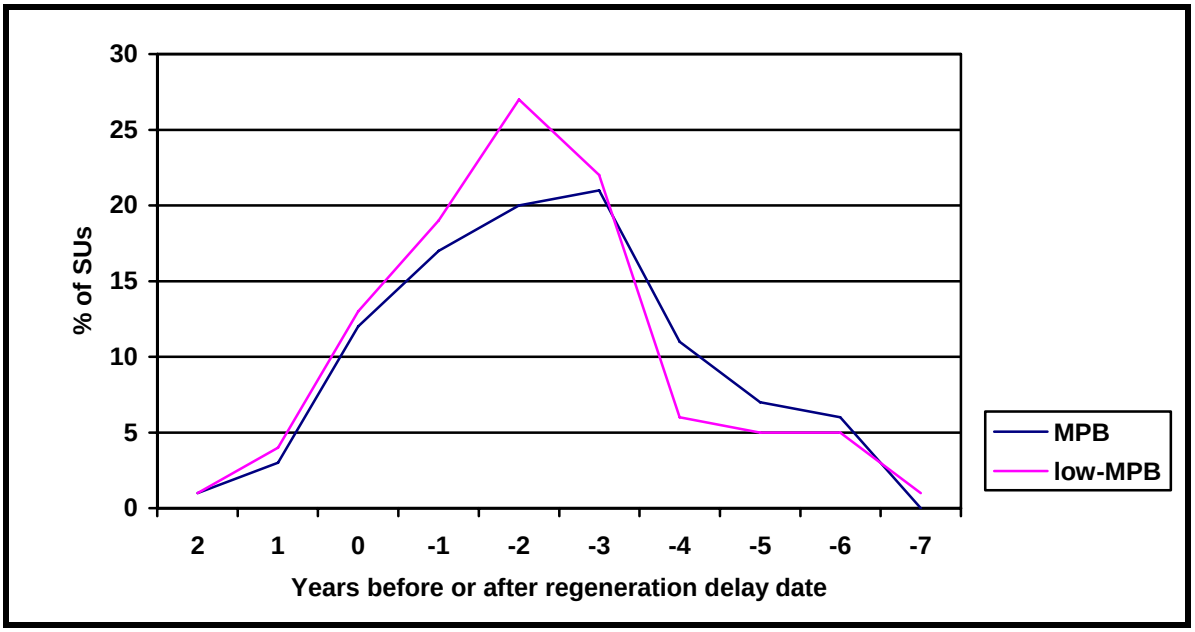
In Table 2, row 0 in column one represents the regeneration delay date. The table shows the timing of the regeneration declaration relative to the regeneration date. Negative numbers are years prior to the specified regeneration date. Figure 1 graphs the results for the pine-leading cutblocks for the MPB-districts and the low-MPB districts.

The timing of regeneration declarations, for cutblocks harvested between 1995 and 2000, is the same for the MPB-districts and for the low-MPB- districts.

Table 2: Proportion of standard units (SUs) with regeneration declaration showing the declared date versus due date (in years from due date which is shown as 0)

Years from Regeneration Delay	MPB Districts			Low-MPB Districts			TOTAL
	Non-Pine	Pine	Total	Non-Pine	Pine	Total	
-7	0%	0%	0%	0%	1%	0%	0%
-6	2%	6%	5%	2%	5w%	3%	4%
-5	5%	7%	7%	2%	5%	3%	4%
-4	4%	11%	9%	5%	5%	5%	6%
-3	19%	21%	21%	22%	22%	22%	22%
-2	29%	20%	23%	28%	29%	28%	27%
-1	21%	17%	18%	21%	16%	19%	19%
0	13%	12%	12%	14%	12%	13%	13%
1	5%	3%	4%	3%	4%	4%	4%
2	1%	1%	1%	1%	1%	1%	1%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure 1. Proportion of pine-leading SUs declaring regeneration early or late



Cutblocks harvested between 2000 and 2004

An assessment cannot yet be done for cutblocks harvested as recently as 2004 (as the due date may be in the future). However, an assessment can be made of the average time delay for planting following harvest and also the proportion of the harvested area that has been planted.

Table 3: Mean number of years between harvesting and planting and percent area planted for cutblocks harvested between 2000 and 2004

	Mean years to plant following harvest	% Area Planted
MPB-districts	**1.7**	**86**
Low-MPB-districts	**1.7**	**87**

The results show (Table 3) that for those openings harvested after 2000 and then planted, the mean time for planting following harvest was the same for MPB-districts and for low-MPB-districts (1.7 years). The proportion of post-2000 cutblocks that were planted prior to March 31, 2004, is also indicated in Table 3. The MPB-districts averaged 86 percent of the recent cutblocks planted, while the low-MPB-districts averaged 87 percent planted.

The regeneration effort (percent area planted and mean regeneration delay following harvest), for cutblocks harvested between 2000 and 2004, is the same for MPB-districts and low-MPB-districts.

3. Species Selection

Species diversity, within and among stands, can help create a future forest that is more resilient to disturbances such as insects, diseases, drought, and climate change. The risk of a future outbreak of mountain pine beetle is increased if present-day reforestation creates large areas of pine forests. The risk of damage by other agents that target pine is increased as well (e.g., Dothistroma foliar disease, rusts, etc). This risk was assessed by determining the proportion of harvested area that is being reforested with lodgepole pine.

Species selection for reforestation in the three MPB-districts was compared with the low-MPB-districts. The comparison was made between cutblocks harvested from 1995-2000 and cutblocks harvested from 2000-2004.

Species composition classes were determined for the cutblock area prior to harvest and post-harvest. The pre-harvest data was from RESULTS using the stand label from the inventory. The post-harvest data was from RESULTS using the current forest cover.

The data was sorted into six classes depending on the dominant tree species in the original opening:

1. Mixed-pine – pine leading but containing less than 80 percent pine
2. Mono-pine – greater than 80 percent pine
3. Mixed conifer – spruce or fir leading but containing less than 80 percent of one species
4. Mono-conifer – greater than 80 percent spruce or fir
5. Mixed deciduous – aspen leading but containing less than 80 percent aspen
6. Mono-deciduous – greater than 80 percent aspen

Figure 2A. Pre- and post-harvest species composition 1995-2000 and 2000-2004 for MPB-districts

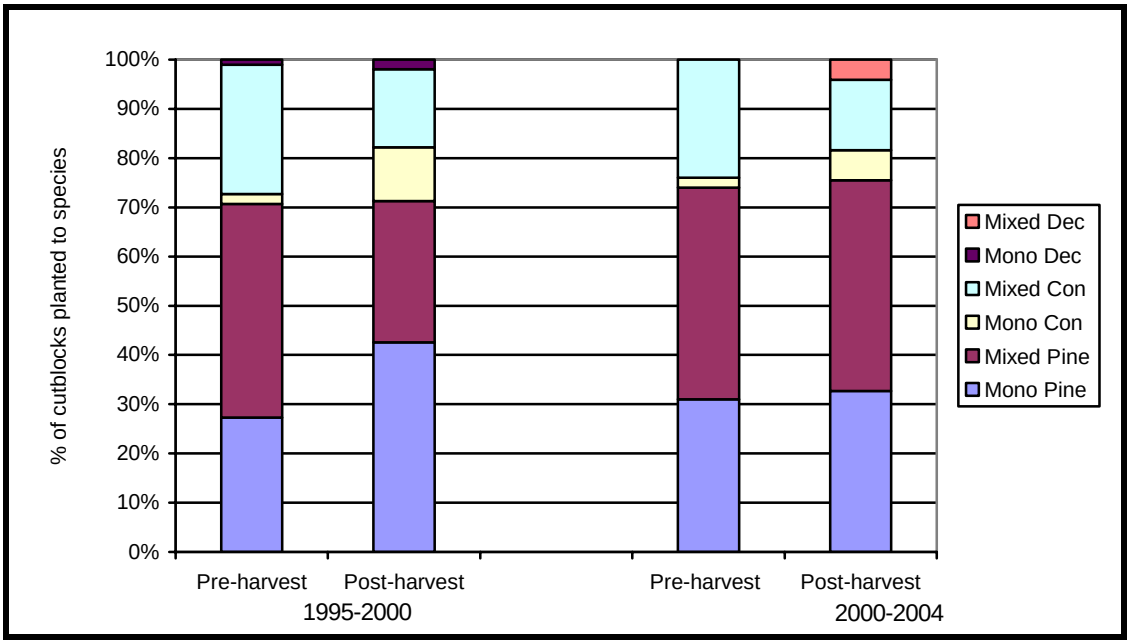
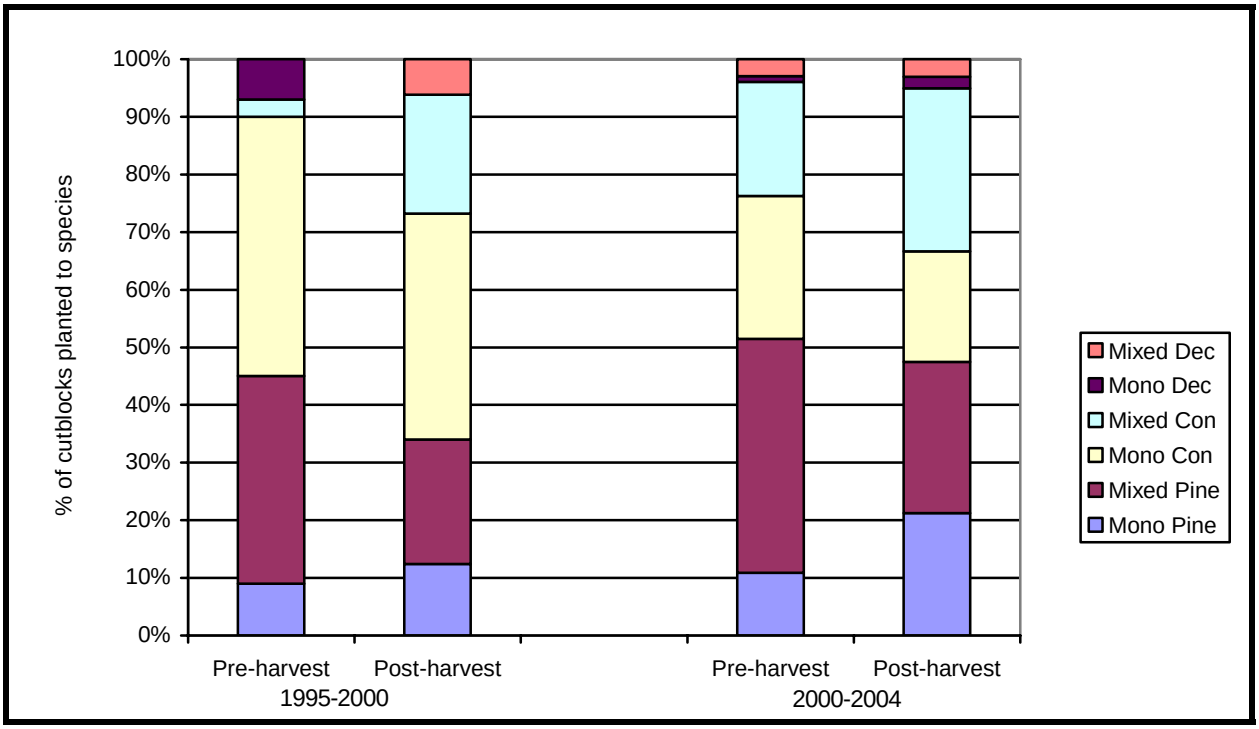


Figure 2B. Pre- and post-harvest species composition 1995-2000 and 2000-2004 for low-MPB-districts



1) Cutblocks harvested between 1995 and 2000

In the MPB-districts (Figure 2A), 70 percent of the harvested area was pine leading. The inventory indicated 27 percent was mono-pine and 43 percent was mixed-pine, with the remainder being deciduous or mixed conifer. The post-harvest regeneration data showed similar levels of pine-leading at 71 percent; however, the proportion of mono-pine has increased to 41 percent from 27 percent pre-harvest.

In low-MPB-districts (Figure 2B), 9 percent of the pre-harvest area was mono-pine and 35 percent was mixed-pine. The area of mono-pine, post-harvest (11%), is slightly higher than pre-harvest, The total area of pine-leading, both as mixed and mono, is less post-harvest (33 percent) compared to pre-harvest (45 percent).

2) Cutblocks harvested between 2000 and 2004

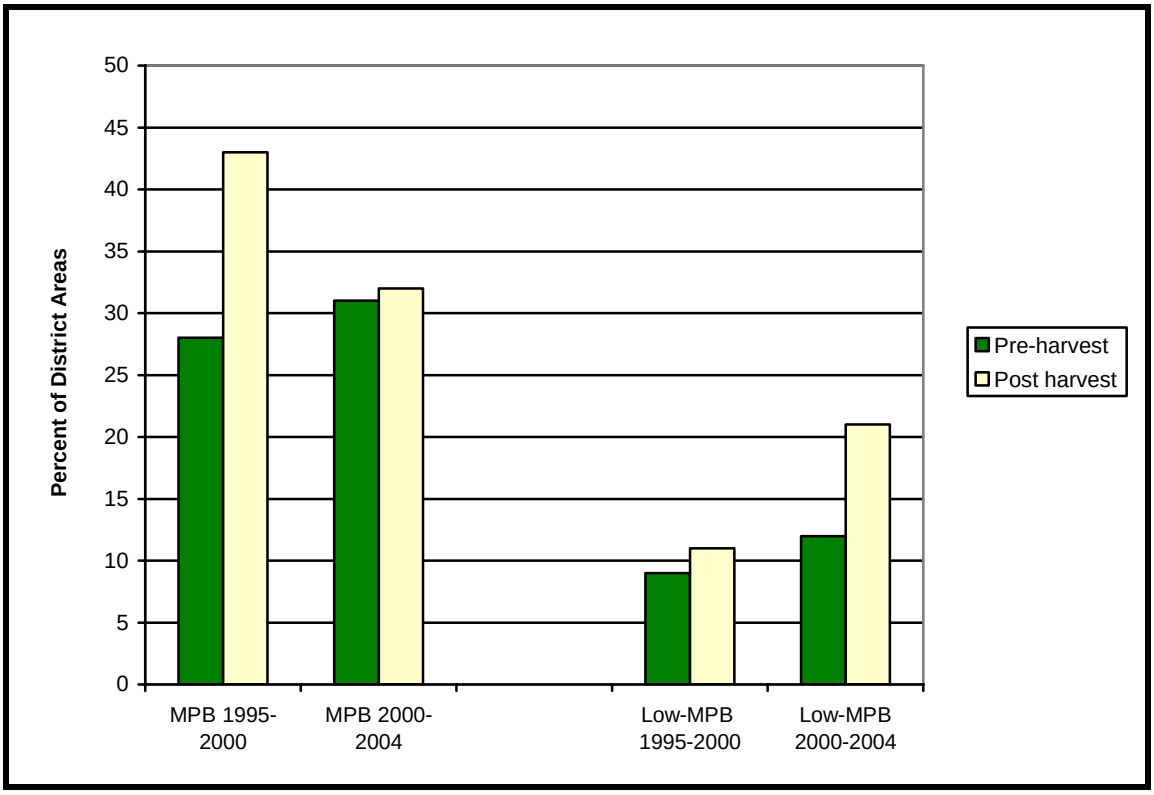
In the MPB-districts (Figure 2A), 73 percent (31 percent mono-pine and 42 percent mixed-pine) of the pre-harvest area was pine leading. The post-harvest regeneration data showed very similar levels of both pine leading (73%) and the proportion of mono-pine (31%).

In the low-MPB-districts (Figure 2B), the area of mono-pine has doubled from 11 percent pre-harvest to 21 percent post-harvest. The total area of pine-leading has remained the same , at around 50 percent.

4. The Growth of Mono-Pine Areas

Large areas of similar-aged mono-pine may be considered undesirable, as the risk of future infestations of MPB is increased. Therefore, the investigation looked at the total area regenerated in mono-pine over the two time periods—1995 to 2000 and 2000 to 2004—in the MPB and the low-MPB districts.

Figure 3. Percent of area occupied by mono-pine, pre- and post-harvest, in cutblocks harvested between 1995 and 2000 and between 2000 and 2005



In the MPB-districts, in cutblocks harvested between 1995 and 2000, there was an increase in area of mono-pine following harvest, from 28 percent to 43 percent (Figure 3). In cutblocks in the MPB-districts harvested between 2000 and 2004, the trend shifted and there was an equal area in pre and post-harvest mono-pine.

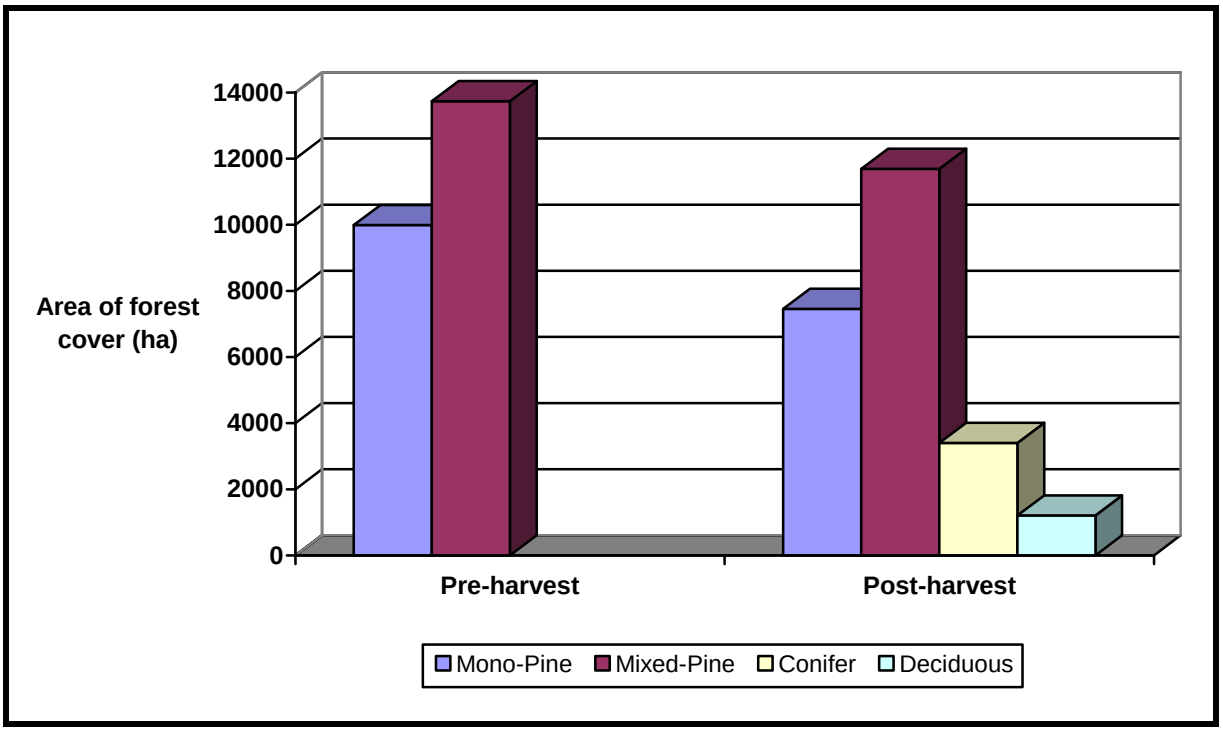
The amount of mono-pine area in the low-MPB-districts showed a significant increase in mono-pine area following harvest in 2000-2004 . The area of mono-pine increased in the 2000-2004 period from 12 percent to 21 percent, a near-doubling of the area planted to mono-pine

For all interior districts combined, there has been an increase of 6% in area planted with mono-pine pre-harvest compared to post harvest during the period 1995-2004.

5. Species Conversion on Pine Sites

Following logging of pine, many (but not all) sites can be regenerated to pine again or to another species or mixes of species suited to the site. A random selection of cutblocks of mono-pine or mixed-pine from the MPB districts, totaling 24,000 hectares, was assessed to determine the area of species conversion on sites previously occupied by mono-pine and by mixed-pine. Only the cutblocks harvested from 2000 to 2004 were assessed.[6]

Figure 4: Species conversion on 24,000 hectares of mono-pine and mixed-pine forest in the three MPB-districts for stands harvested between 2000 and 2004



Following the harvest of 10,000 hectares of mono-pine forest, 7,455 hectares of mono-pine and 2,545 hectares of other species was planted on these sites. Therefore, there has been a conversion from mono-pine to either mixed-pine, conifer or deciduous in 25 percent of the harvested area. In addition, there has been a conversion of 2,050 hectares of mixed-pine to other conifer species or deciduous.

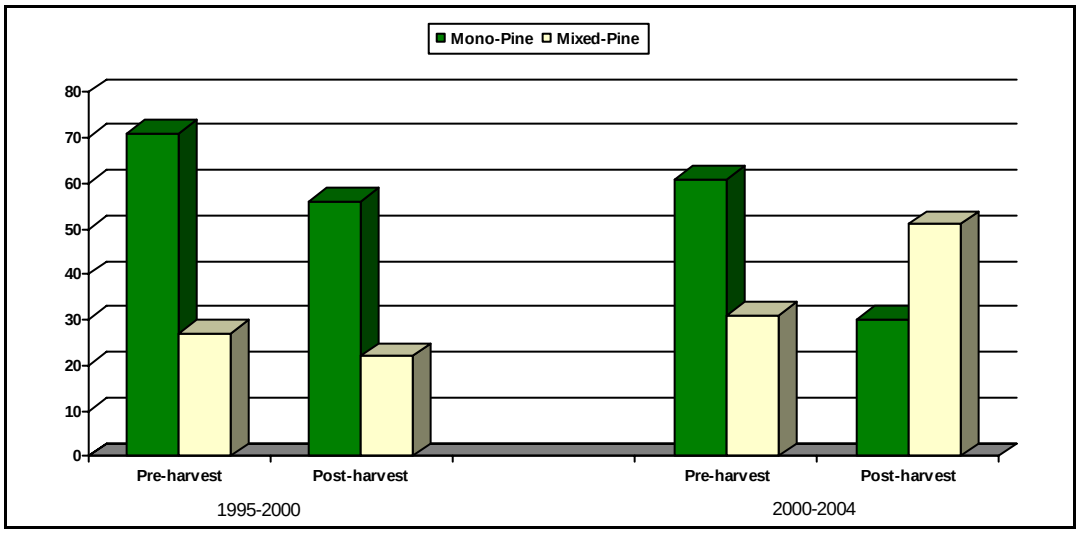
[6] Note that only those records that had filled in previous stand labels and forest cover stand labels can be used (2849 records were not used due to missing previous stand label of total of 5212).

CASE STUDY: Baker Creek Landscape Unit

The Forest Practices Board is tracking the management of mountain pine beetle for a number of resource values in the Baker Creek landscape unit, west of Quesnel. It provides an example of a single landscape unit that is at the centre of the mountain pine beetle attack (Figure 5). A series of upcoming board reports on mountain pine beetle harvesting will examine this landscape unit as a case study.

This area was assessed for species conversion following harvest. The analysis, conducted at the single landscape unit scale, may more realistically reflect species management than one conducted at the whole-district scale.

Figure 5: Percentage of SUs with mono-pine or mixed-pine in Baker landscape unit, the Quesnel Forest District, for areas logged 1995-2000 and 2000-2004

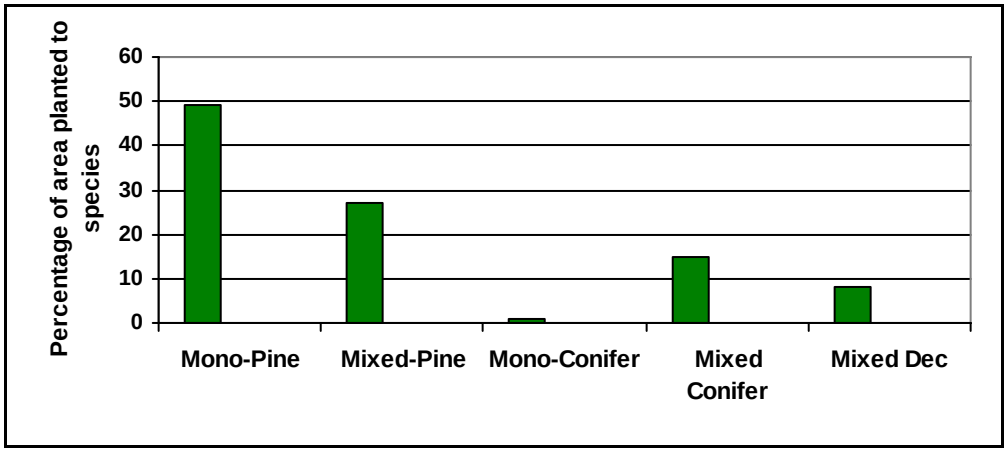


Baker Creek cutblocks logged between 1995 and 2000 were 71 percent mono-pine and 27 percent mixed-pine. Following harvest and planting, 56 percent were mono-pine and 22 percent were mixed-pine. For this time period, there was a decrease of 15 percent in mono-pine.

Cutblocks logged between 2000 and 2004, as the beetle infestation became epidemic, targeted less mono-pine (61 percent) and more mixed-pine (31 percent). Following harvest and planting, a significantly smaller area was planted to mono-pine (30 percent) than mixed-pine (51 percent).

Cutblocks in mono-pine in the Baker Creek landscape unit, harvested between 2000 and 2004, show a change in species composition following harvest (Figure 6). Mono-pine was planted on 46 percent of the SUs and mixed-pine was planted on 26 percent. Mixed conifer was planted on 14 percent and mixed deciduous was planted on 7 percent.

Figure 6. Conversion of mono-pine forest stands to other planted species



The Board concludes that the shift away from mono-pine planting to mixed pine and other conifer species, as noted above in the Quesnel Forest District analysis, is also apparent at the landscape unit scale in the most intensive area of beetle infestation. The shift to mixed pine planting occurred at an earlier stage (1995-2000) than in the rest of the MPB districts.

Discussion

The main issue for reforestation of MPB-attacked areas is how to reforest in the most efficient manner and, at the same time, further increase species diversity. It is widely believed that increased diversity of tree species may help ensure the future forest is as resilient as possible to future beetle epidemics, or in the case of another epidemic, that it retains as much value as possible.

This investigation has revealed that the issue of species diversity in mountain pine beetle affected areas is less one of pine monocultures, and more one of leading species dominance and the lack of diversity between blocks. Many young stands lack a significant secondary species. Most mixed species plantings in these areas are a standard 70 percent pine and 30 percent spruce. To a degree, a different kind of uniform forest type is being created.

There is also a lack of diversity between stands at the landscape level. The current policy framework does not provide the ability to set standards for diversity within a single cutblock or over multiple cutblocks. Within a standards unit, any one or combination of preferred species is equally acceptable. Over multiple cutblocks, no species control mechanisms are in place. To achieve species composition diversity there is no strategic planning guidance or specific targets for composition and diversity at scales greater than the individual standards unit. There is no requirement to, and few current examples of, the active management of species composition in cutblocks to create a target landscape- or forest-level composition. The Ministry of Forests and Range is currently working on this—analyzing policy options and trying to work within the current regulations to promote species diversity.

Establishing species targets at the landscape scale would help achieve broad species diversity objectives, while allowing appropriate site level prescriptions to be developed. One possible solution would be to make approval of the forest stewardship plan stocking standards contingent on meeting species diversity targets at the landscape level. This would require an amendment to the *Forest Planning and Practices Regulation* regarding the approval of stocking standards. In order to plan and monitor landscape level targets, RESULTS would have to be upgraded to be able to report on species diversity, and compare achieved composition to target composition, both within cutblocks and amongst groups of cutblocks.

Conclusion

This report has examined the timing of regeneration and the species composition of re-forested areas following harvest of mountain pine beetle affected forests in the central interior of British Columbia.

For the period of assessment, reforestation in the districts most heavily affected by the mountain pine beetle epidemic was well within the regeneration window, and is slightly more punctual than in districts outside the areas hardest hit by the mountain pine beetle. The timeliness of planting is similar in the MPB-districts and low-MPB-districts. The percent area of planting is also similar in MPB and low-MPB districts.

Reforestation with pine or mixed-pine in previously pine-dominated stands was found to be the norm. Pine remains the most productive and reliable conifer species for reforestation in most of the MPB areas. For the 1995-2000 time period, when the MPB attack was beginning, more area was being planted to mono-pine than existed prior to harvesting. During the 2000-2004 period, there was a shift in practices and an equal area was planted to mono-pine compared to the harvested area of mono-pine over the four year period.

Uptake of mixed-species planting has been slower in the low-MPB districts. There has been a net increase in areas planted to mono-pine over the last ten years. In the 2000-2004 period ,the percentage area of mono-pine doubled.

For all interior districts combined, there has been an increase in area planted with mono-pine of 6% pre-harvest to post harvest during the period 1995-2004. The total area of pine- leading (mono + mixed), for all interior districts combined, has remained relatively constant, at 53%, pre-harvest and post-harvest, from 1995-2004.