Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak:

Update of the projection of non-recovered losses for the reference management scenario

Based on the 2005 Provincial Aerial Overview of Forest Health and revisions to "the model" (BCMPB.v3)

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1.0 Introduction

For three years we have been developing a Provincial-Level Mountain Pine Beetle Model (BCMPB)[1]. The model uses forest cover maps[2], the Provincial Aerial Overview of Forest Health[3] and information from a stand level mountain pine beetle (MPB) population model[4] to estimate the extent of the pine mortality caused by the outbreak to date and to project the possible course of the infestation into the future. The projection of the infestation based on the 2005 Provincial Aerial Overview of Forest Health is presented elsewhere[5].

This year, we have revised portions of the provincial scale model related to the projection of the forest management response to the outbreak. Updates to the model are detailed elsewhere[6]. The most important changes include:

- revisions to the parameters used in the shelf-life model;
- explicit inclusion of harvest targets for non-pine volume based partially on previous performance; and
- explicit inclusion of an "alternative" industry in the Lakes, Quesnel and Prince George TSAs. This industry has a harvest target for pine volume that has passed the shelf-life for sawlogs.

We have also improved the output capabilities of the model by distinguishing between standing volume that is both constrained from harvest and volume that is unconstrained.

In this document we update the conclusions made last year[7] about volumes of pine harvested, available and lost under the reference scenario. The reference scenario is defined in detail elsewhere[8]. In essence, it is our attempt to reflect current management practices and assumptions. Notably, the total harvest target for each management unit is set at the Allowable Annual Cut (AAC) for January 1, 2006. We focus our modeling efforts and conclusions on the "pine units"; those Timber Supply Areas (TSA) where pine represents more than 10% of the volume on the Timber Harvesting Landbase (THLB). Those units are 100 Mile House, Arrow, Boundary, Bulkley, Cranbrook, Dawson Creek, Golden, Invermere, Kamloops, Kootenay Lake, Lakes, Lillooet, Mackenzie, Merritt, Morice, Okanagan, Prince George, Quesnel, Robson Valley, Williams Lake.

[1] http://www.for.gov.bc.ca/hre/bcmpb
[2] http://www.for.gov.bc.ca/hts/vri/
[3] http://www.for.gov.bc.ca/hfp/health/overview/overview.htm
[4] http://www.pfc.forestry.ca/entomology/mpb/tools/modeling/mpbsim_e.html
[5] http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v3.BeetleProjection.Update.pdf
[6] http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v3.ModelDocumentation.Update.pdf
[7] http://www.for.gov.bc.ca/hre/bcmpb/BCMPB_MainReport_2004.pdf
[8] http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v3.ModelDocumentation.Update.pdf

2.0 Projection of the volume of pine harvested, available and lost under the reference scenario

At the beginning of the projection in 2006, we estimate that there are 1.1 billion m^3 of merchantable pine on the THLB in the 20 "pine units". This represents 40% of the total merchantable volume of 2.7 billion m^3. However, in 2006 not all of that pine is "equal" in value. Over one third of the standing volume at the beginning of 2006 (prior to the beetle flight that will occur this summer) has been killed (Table 1). In 2006 the reference scenario harvests 33 million m^3 of pine that could be used for dimensioned lumber or chips. We estimate that an additional 4 million m^3 of "residue" will be harvested because it will be in cutblocks that are harvested in the process of harvesting the valuable pine.

Table 1. Summary of the status of the pine volume in 2006 and 2016 under the reference scenario

	Projection Year	
Pine Volume (millions m^3)	2006	2016
Standing Live Pine	694	136
Standing Dead Pine[9]	377	529
Harvested Valuable Pine	33	417
Harvested Pine Residue	4	62
Total	1,109	1,109

The results of the projection of the reference scenario indicate that it is not reasonable to continue to project current management beyond 2016. Some of the units with Allowable Annual Cuts (AACs) that have been increased to deal with beetle salvage will be experiencing severe shortages of available volume by that time and we expect that the infestation will have largely subsided. Most dramatically, in the reference scenario the Vanderhoof Forest District portion of the Prince George TSA is only able to meet 86% of its harvest target in 2015 due to a lack of unconstrained volume. By 2016, constraints on harvesting result in only 3% of the harvest target being met.

By 2016 just over 10% of the volume of pine that exists in 2006 may be left alive on the landbase. Nearly half the volume will still be standing dead and we will have harvested nearly 40% of the pine volume. The reference scenario projects that an additional 173 million m^3 of non-pine volume will be harvested in the 20 "pine units" over the next 10 years (Table 2). That will be just under 30% of the total harvest.

[9] We estimate that a total of 45 million m^3 of dead pine, not accounted for in inventory depletions, was harvested between 1999 and 2006. This accounts for the discrepancy between the volume of standing dead pine (377 million m^3) and the total pine mortality of 421 million m^3 reported in http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v3.BeetleProjection.Update.pdf

We obtain detailed information about the projected status of pine from the model. In this context we think it is useful to report on 12 categories of pine as shown in Figure 1.

We show four divisions using different colours in Figure 1. These represent pine volume at different times since death and are described based on their utility for various products using our shelf-life model:

- Live pine: merchantable and susceptible pine that has not been killed by mountain pine beetles.
- Sawlogs: dead pine that has been killed recently enough that it is still suitable for the manufacture of dimensioned lumber products.
- Chips: pine that has been dead long enough that it is no longer suitable for dimensioned lumber products but is still useable for "alternative" products such as oriented strand board or bio-fuel.
- NRL: Non-recovered loss. Pine that has been dead for so long that it is no longer useable even for alternative products.

Each of the four types of pine volume are further subdivided into three categories using hatching:

- LOGGED: Volume that has been harvested.
- CONSTRAINED: Volume that is constrained from harvest because it is in stands that have too little volume, are too far from a road, or are constrained by Visual Quality Objectives.
- AVAILABLE: Volume that could be harvested without constraints.

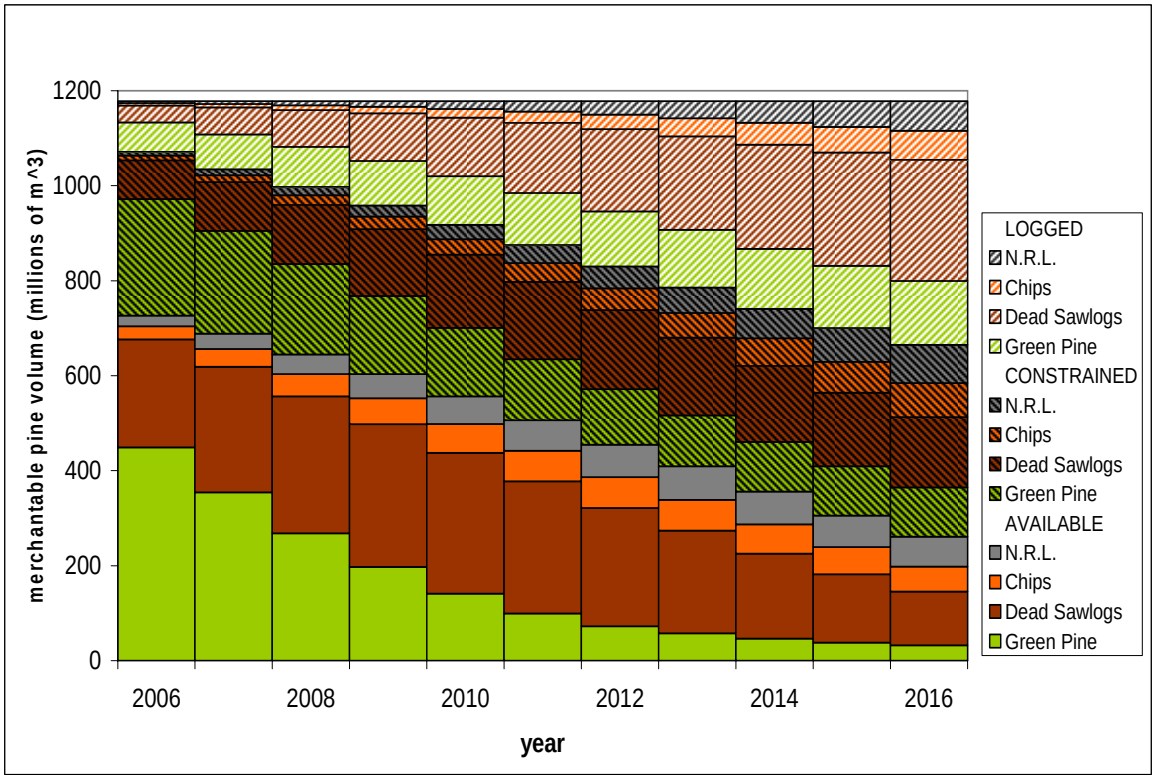

Figure 1. Projected proportion of merchantable volume on the THLB in the 20 pine units in various categories (see text).

Figure 1 shows that there is a large amount of pine in 2006 that is unavailable for harvest given the assumptions. The most important constraint is the minimum volume per hectare that is considered to be eligible (economical) for harvest. We assume that a stand that is being harvested as a "green", or living, stand must have at least 150 m^3/ha and a salvage stand must have at least 100 m^3/ha. If we reduce these volume per hectare constraints to 100 m^3/ha and 75 m^3/ha respectively, the total available volume in 2016 increases from 198 million m^3 to 298 million m^3.

The total volume that is constrained decreases by only 4% over the projection period (337 million m^3 to 323 million m^3). Some volume that is initially constrained becomes unconstrained as the road system is expanded. Some volume that is initially available becomes constrained as harvesting occurs in areas with Visual Quality Objectives and as the dead volume deteriorates beyond its useable shelf life.

The total non-recovered loss is made up of harvested (residue) non-recovered loss and standing non-recovered loss that is either available and constrained. The total loss in 2006 is estimated to be 34 million m^3. By 2016 we estimate that loss will rise to 206 million m^3. These estimates are highly dependent on assumptions about the shelf life of beetle-killed volume.

Not surprisingly, there is significant variability in the absolute amount of non-recovered loss experienced by management unit over the next 10 years (Table 2). This variability is particularly dramatic when the non-recovered loss is expressed as percentage of the volume of pine that is harvested over 10 years (Table 2). Some explainable trends appear to emerge although a complete explanation is difficult.

Units that have much higher than average proportional losses:

- have a relatively low percentage of pine on the THLB and that pine is unusually widely dispersed in stands that are not pine leading (Kootenay Lakes and Arrow); or
- are heavily constrained by road access (More than 20% of the THLB in Fort Saint James and Mackenzie is more than 2 km from a road); or
- are experiencing very heavy mortality early in the outbreak and have no increase in AAC to deal with the salvage (100 Mile House, Williams Lake), or
- are difficult to explain (Lillooet).

Units that have much lower than average proportional losses:

- have pine that is distributed in such a way that is not heavily constrained by road access and is reasonably concentrated on the landbase (Boundary, Invermere, Kamloops and Robson Valley); and/or
- have AACs that have been increased sufficiently to reduce the losses below the average amount (Vanderhoof, Okanagan and Prince George).

Note that notwithstanding the increases in the AACs in the Lakes and Quesnel TSAs these units still experience nearly the average non-recovered losses. The reason for this is that very large volumes have been killed very rapidly in areas of these TSAs

that are poorly roaded. Limited road access hampers the effectiveness of increased harvesting.

Table 2. Total volumes of pine harvested and non-recovered loss (millions m^3) from 2006 to 2016

Management Unit	Harvested pine	Non-Recovered Loss	loss as a % of pine harvested
All pine units	417	206	49
More than 10% above mean			
Kootenay Lake	2	2	112
Ft. St. James (District)	24	26	107
Arrow	2	2	79
100 Mile House	15	11	73
Mackenzie	25	17	69
Lillooet	4	3	65
Williams Lake	38	25	64
Within 10% of mean			
Morice	19	11	58
Lakes	28	15	52
Bulkley	5	2	47
Golden	2	1	44
Cranbrook	10	4	44
Quesnel	52	22	42
Merritt	21	9	42
Dawson Creek	9	4	41
More than 10% below mean			
Boundary	5	2	37
Invermere	5	2	37
Vanderhoof (District)	52	18	35
Kamloops	27	9	35
Robson Valley	3	1	33
Okanagan	24	7	31
Prince George (District)	43	13	30

There is significant variability among management units in the distribution of timber volume among the various categories presented in Figure 1. Nonetheless a reasonably consistent overall picture emerges. By 2016:

- The amount of pine harvested as a percentage of the total harvest is at least as great as the proportion of pine on the landbase.
- There are very large volumes of standing dead pine.
- The amount of dead pine that is "available" for harvest is much smaller than the amount of standing dead pine. However, the amount that is available depends entirely on assumptions about shelf life and harvesting constraints, notably the minimum volume per hectare that will be harvested.

3.0 Conclusions

Given current AACs in the 20 "pine units" and our assumptions about the shelf life of beetle-killed pine we estimate that over 200 million m^3 of pine will be categorized as non-recovered losses by 2016. It is important to note that this is a provincial scale conclusion based on a relatively simplistic model. Nonetheless, it seems clear that estimates of non-recovered losses will be substantial regardless of the level of detail of modeling that is undertaken. In general our model can be faulted for being too unrestrictive with respect to forest harvesting. Notably, the only non-timber constraint we include is visual quality objectives. Therefore, the estimates of non-recovered losses are likely optimistic.

Additionally, the losses are likely optimistic because of our assumptions about the usability of the "chip" component of the dead volume. We assume that there is a longer shelf life for "chips" than for sawlogs and that there is an industry that can use those chips. Whether or not those assumptions are correct remains to be seen. There are emerging industries that have expressed an interest in utilizing this low quality pine for a variety of purposes such as oriented strandboard and bioenery. However, there has been a general assumption in our modeling efforts that the existing pulp industry will utilize the bulk of the chips. It is in fact likely that the pulp industry has a sufficient supply of chips as a result of increased harvest of sawlogs, and also that chipping whole logs to produce pulp is not economically viable (Paul Watson, Paprican, Personal Communication).

We estimate that by 2016 there will be a total of 185 million m^3 of volume in the "chip" category. If, in fact, the pulp industry cannot use this volume then much of it will become a non-recovered loss. We project that a total of 61 million m^3 is of "chip" quality volume will be harvested by 2016. However, the "alternative" industry in the 3 units with expedited increases for salvage (Lakes, Quesnel and Prince George) will only take 38 million m^3 at the current AAC and that will occur only if they begin harvesting the full AAC this year. It therefore seems reasonable to assume that the total non-recovered losses may be at least as high as 353 million m^3 (206 "known" non-recovered losses + 185 "chip" volume – 38 chips harvested by the alternative industry)

We do not report on any sensitivity analysis in this update. We have conducted sensitivity analysis to ensure that the model is operating properly. Those analyses included alternatives such as omitting Visual Quality Objectives and decreasing the minimum harvest volumes. The results of these analyses simply verify that the model is performing as expected. Last year we reported extensively on what we thought were interesting sensitivity analyses. These were sensitivities about significant uncertainties in:

- When the infestation will end
- The shelf life of beetle-killed pine
- The response of the industry to the opportunity to salvage

All three of these uncertainties still exist. There is little or no value in re-examining what are essentially the same uncertainties with the same model.