TIMBER SUPPLY ANALYSIS:

FERTILIZATION OF NON-MOUNTAIN PINE BEETLE STANDS ON THE PRINCE GEORGE TIMBER SUPPLY AREA

Version 1

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Attention: Ralph Winter, RPF
Stand Management Officer

Reference: Fertilization of Non-Mountain Pine Beetle Stands Analysis

Dear Ralph,

Enclosed please find the report *Timber Supply Analysis: Fertilization of Non-Mountain Pine Beetle Stands on the Prince George Timber Supply Area*. It summarizes the results of the analysis coordinated by Mel Scott on your behalf.

Please review the results and contact me if you have any questions or comments. Thank you for your support during the analysis.

Yours truly,

TIMBERLINE FOREST INVENTORY CONSULTANTS LTD.

Bill Kuzmuk, RPF
Forester, Resource Analysis

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1.0 INTRODUCTION

The recent infestation of Mountain Pine Beetle (*Dendroctonus ponderosae*) (MPB) has reached critical levels throughout the interior of British Columbia. Many of the timber supply areas (TSAs) have increased allowable annual cut (AAC) levels to address salvage of dead and damaged timber, or to allow harvesting that will reduce the spread of the beetle. The impact of this far-reaching outbreak of MPB will greatly affect the forest with regard to timber and other resource values.

In response to a request by the Ministry of Forests and Range (MoFR), Timberline conducted a timber supply analysis on the Prince George TSA to evaluate the impacts of fertilization on stands not affected by the MPB outbreak. Data used for the fertilization analysis is from the recent MPB Impact Analysis completed for the Council of Forest Industries (COFI) as documented in *Timber Supply Analysis: Mountain Pine Beetle Impact on Interior Timber Supply Areas* (Timberline 2006). This data, initially provided by Forest Analysis Branch of MoFR had been used in the timber supply review (TSR 2).

The objective of the analysis is to evaluate the benefit of fertilization on timber supply, especially in the mid-term, after pine stands have either been salvaged or rendered unmerchantable as a result of MPB attack. It is during this timeframe that impacts of the MPB outbreak are worst. An existing timber supply analysis data set has been used with minor revisions to address additional harvest and potential losses in pine-leading stands. It was not possible to isolate all pine volume, *ie*. minor pine volume in other stands, to assess how this might affect timber supply because of time requirements and source the nature of the data used.

Fertilization candidates were identified based on criteria provided by MoFR. However, similar to identifying pine stands, the format of the analysis data sets limited the resolution for selecting Douglas-fir (fir) and spruce stands that are considered suitable for treatment.

Modelling was completed using FSSIM (version 3.0) for the Prince George TSA.

The analysis used the concept of "shelf life" which defines the length of time beetle-killed pine trees will remain merchantable after attack. Shelf life estimates use site moisture classification methods outlined in the report *Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMPBv2) and Results of Year 2 of the Project* (CFS/MoFR, April 2005). This report describes the use of BEC subzone to classify sites as wet, moist or dry (Appendix 4). Section 2.4 of this report summarizes the shelf life assumptions for this analysis.

It is important to note that there are many possible ways to approach the strategic analysis of a land base that has experienced a serious outbreak of MPB. Changes to assumptions for shelf life, stands at risk to attack and subsequent loss of merchantability, and constraints related to non-timber resources can provide different results. To provide consistency this analysis has used the same assumptions that were included in the COFI MPB analysis. Given data and model availability the inputs and assumptions used are considered reasonable for modelling the MPB issue.

1.1 Analysis Scenarios

Three scenarios related to treatment levels were completed in the current analysis. All sceanarios are based on the "Baseline with MPB Target" scenario from the COFI MPB analysis. This scenario modelled the new assumptions for pine at risk to attack by MPB. However, the at-risk pine stands are given the highest priority for harvest in the short-term (15 years) to maximize the recovery of this timber prior to complete loss. A description of the each scenario is provided below.

One Fertilization Application. Candidate fir and spruce stands have been treated with one application of fertilizer during the 10 year prior to harvest. This provides an additional 15 cubic metres of merchantable volume at harvest.

Two Fertilization Applications. A second application is included in this scenario, providing 30 cubic metres of merchantable volume (*ie*. cumulative with the first application) of additional volume at harvest compared to the Baseline.

Three Fertilization Applications. Three fertilization treatments are completed on all eligible stands in this scenario, thereby providing 45 cubic metres of additional volume .

2.0 METHODOLOGY

The following sections outline the methodology employed for the Prince George TSA fertilization analysis.

2.1 TSA Selection

Initially, three TSAs from the interior of B.C. were to be included in the analysis. These were selected based on discussions with MoFR. However, after a preliminary review of the candidate areas from each TSA, the Quesnel and 100 Mile House TSAs were dropped from the analysis. The amount of area potentially available for treatment was considered too small to show any reasonable change in timber supply. Therefore only the Prince George TSA has been modelled in the fertilization analysis.

2.2 Data Acquisition

MoFR Forest Analysis and Inventory Branch initially provided the Prince George TSA data set for the recent COFI MPB timber supply analysis. The most recent TSR (TSR-2) FSSIM Base Case data was delivered. The data set was then modified for modelling MPB assumptions (for the COFI MPB analysis) and fertilization treatments as outlined in the following sections.

2.3 Data Preparation

Upon receipt of TSA data sets a review of analysis inputs (analysis units, resource emphasis areas, harvest partitions, *etc*.) was conducted. Assignments of these inputs were modified as needed to address assumptions for MPB. Pine stands at risk were isolated from other pine stands and modelled on separate yield tables to allow modelling of revised assumptions.

Similarly, fir and spruce stands within the timber harvesting land base (THLB) were isolated for treatment based on the following general characteristics from MoFR:

- Douglas-fir stands less than 80 years of age, any site index; and
- Spruce stands less than 80 years of age site index 15 – 25.

It was not possible to identify the specific site index range for spruce stands. Therefore all stands with site index greater than 12.0 were included in the treatment type.

2.4 Modelling Assumptions

Modelling inputs and assumptions were developed from the TSR-2 Base Case. It was necessary to update the inventory to reflect harvesting in recent years. This was achieved by modelling the first 5-years of the analysis using known AAC levels and management assumptions from the previous analysis. This addresses depletions and growth over the past five years. Reporting of results for the fertilization analysis is from year six (the beginning of the second 5-year period) forward. A description of the methodology for modelling fertilization, and MPB attack and related mortality follows.

Shelf Life

As stated in the *Introduction* (Section 1.0), each pine stand was assigned to a moisture category using MoF/CFS methods. Each moisture category was then give a shelf life. Based on discussions with COFI and some licensee representatives, the following assumptions for shelf life were modelled in this MPB analysis:

- Wet sites – five years;
- Moist sites – 10 years; and
- Dry sites – 15 years.

Complete attack by MPB is assumed to be complete at year one of the simulation for the Prince George TSA. The year after full attack is when shelf life begins. The shelf life assignments do not relate to merchantability of the volume harvested, *ie*. sawlogs, chips, *etc*.

Pine Growth & Yield

Existing analysis unit definitions for pine stands were used as a framework for modelling pine stands at risk to attack. Pine stands at least 60 years old and either pine leading were assumed to be at risk to MPB attack. A duplicate set of pine analysis units was developed based on the existing framework and the distribution of the BEC shelf life categories. A duplicate yield table (typically natural stand yield) was used to model the growth of these pine stands during the first 15 years of simulation.

At-risk pine stands harvested within the assumed shelf life period contributed full volume to the periodic harvest and regenerated to their preferred silviculture regime. If any pine stands were not harvested before their shelf life expired, they were assumed to have no merchantable volume and therefore did not contribute to the periodic harvest. In addition these unsalvaged areas regenerated to a reduced natural stand yield table (80% of Base Case) with a 15-year regeneration delay. This was intended to represent no managed regeneration on the impacted areas and loss of productive area due to additional debris on the site.

Forest Cover & Salvage

The following assumptions were used in modelling dead pine stands that were not salvaged prior to the expiration of their shelf life:

- MPB pine stands not harvested before the expiration of their shelf life are not considered “disturbed” and therefore do not contribute to the disturbance constraint for any management zone (VOQ, watersheds, IRM/adjacency, *etc*.);
- The regeneration age for these dead sites was set to an age older than all disturbance ages for the various management zones to ensure that the areas were older than the minimum green-up age;
- Rather than applying an extended regeneration delay (which affects green-up related to forest cover constraints) the rotation ages for the regeneration type assigned to these dead stands were extended by at lease 40 years (15 years to account for the regeneration delay and 25(+) years to account for the advanced age of the regeneration.

This set of assumptions applied all scenarios modelled in the fertilization analysis.

Fertilization Volume Gains

Each fertilization application increases merchantable volume by 15 m^3/ha over the Base Case stand volume. The volume enhancement occurs over 10 years and is cumulative for each application. Therefore 45 m^3/ha is gained in the scenario which models three applications.

For analysis purposes, it was assumed that treatment takes place at the correct time to ensure that maximum volume gains coincide with year of harvest.

Harvest Priority & Profile

Pine stands at risk to attack were given the highest priority for harvest in the harvest queue. Those stands assumed to be unaffected by MPB attack did not contribute to the periodic harvest during the first 15 years of simulation (the salvage period) until salvage harvest opportunities had been exhausted. This input was included to force as much of the harvest as possible into pine stands.

Other harvest profile assumptions from the previous Base Case were ignored to allow priority harvesting of pine stands. Non-pine stands could only contribute to the periodic harvest if the at-risk pine had been salvaged before the expiration of the shelf life, up to 15 years. Dry sites account for only 8% of the mature pine on the Prince George TSA therefore harvesting of other stands is necessary to satisfy existing AAC requirements during the last five years of salvage.

In the analysis scenarios which attempted to liquidate all dead pine prior to expiration of the shelf life, the following harvest flow methodology was used:

- Identify the pine volume within each shelf life category;
- Distribute this volume evenly over the shelf life time frame and the years to reach full attack (15 years), recognizing that there are proportionately more wet and moist sites on the TSA and there is a need to force more of the harvest into the earlier periods of simulation; and
- Reduce the harvest as required due to other non-timber resources.

Specific harvest targets were not assigned to fertilization candidates. These stands were given high harvest priority during the period after pine salvage was completed and the treated stands reached merchantable age.

Modelling Periods

The first 20 years of simulation was modelled with 5-year periods, the remainder of the 250-year planning horizon used 10-year periods.

3.0 ANALYSIS RESULTS

3.1 Land Base

Based on the assumptions used to identify fertilization candidates, there are approximately 260,000 hectares of Douglas-fir and spruce stands that could be treated in the TSA. Table 3.1 summarizes the area and volume (THLB only) for the Prince George TSA.

Table 3.1 – Prince George TSA area summary

Land Base Category	Area (ha)	Percent of THLB (%)	Volume (m^3)
Productive non-THLB	1,939,129	n/a	
THLB			
Fertilization types	260,285	8	7,228,000
MPB types	1,215,943	36	326,755,000
Other THLB	1,869,989	56	334,955,000
Total THLB	3,346,216	100	668,938,000
Total productive forest	5,285,345	n/a	

3.2 One Fertilization Application

Table 3.2 summarizes the harvest level for the *One Fertilization Application* scenario, with comparison to the *Baseline with MPB* scenario from the COFI MPB Analysis.

Table 3.2 – Annual harvest – one fertilization application

Simulation Year	Baseline with MPB Annual Harvest (m^3/year)	One Fertilization Application Annual Harvest (m^3/year)	Percent Change from Baseline with MPB (%)
5	14,944,000	14,944,000	0.0
10	14,944,000	14,944,000	0.0
15	8,855,000	8,855,000	0.0
20 - 130	7,662,000	7,701,000	0.5
140 - 250	8,692,000	8,692,000	0.0

3.3 Two Fertilization Applications

Table 3.3 summarizes the harvest level for the *Two Fertilization Applications* scenario, with comparison to the *Baseline with MPB* scenario from the COFI MPB Analysis.

Table 3.3 – Annual harvest – two fertilization applications

Simulation Year	Baseline with MPB Annual Harvest (m^3/year)	Two Fertilization Applications Annual Harvest (m^3/year)	Percent Change from Baseline with MPB (%)
5	14,944,000	14,944,000	0.0
10	14,944,000	14,944,000	0.0
15	8,855,000	8,855,000	0.0
20 - 130	7,662,000	7,733,000	0.9
140 - 250	8,692,000	8,692,000	0.0

3.4 Three Fertilization Applications

Table 3.4 summarizes the harvest level for the *Three Fertilization Applications* scenario, with comparison to the *Baseline with MPB* scenario from the COFI MPB Analysis.

Table 3.4 – Annual harvest – three fertilization applications

Simulation Year	Baseline with MPB Annual Harvest (m^3/year)	Three Fertilization Applications Annual Harvest (m^3/year)	Percent Change from Baseline with MPB (%)
5	14,944,000	14,944,000	0.0
10	14,944,000	14,944,000	0.0
15	8,855,000	8,855,000	0.0
20 - 130	7,662,000	7,776,000	1.5
140 - 250	8,692,000	8,692,000	0.0

Figure 3.1 presents the annual harvest rates developed for the Prince George TSA MPB scenarios.

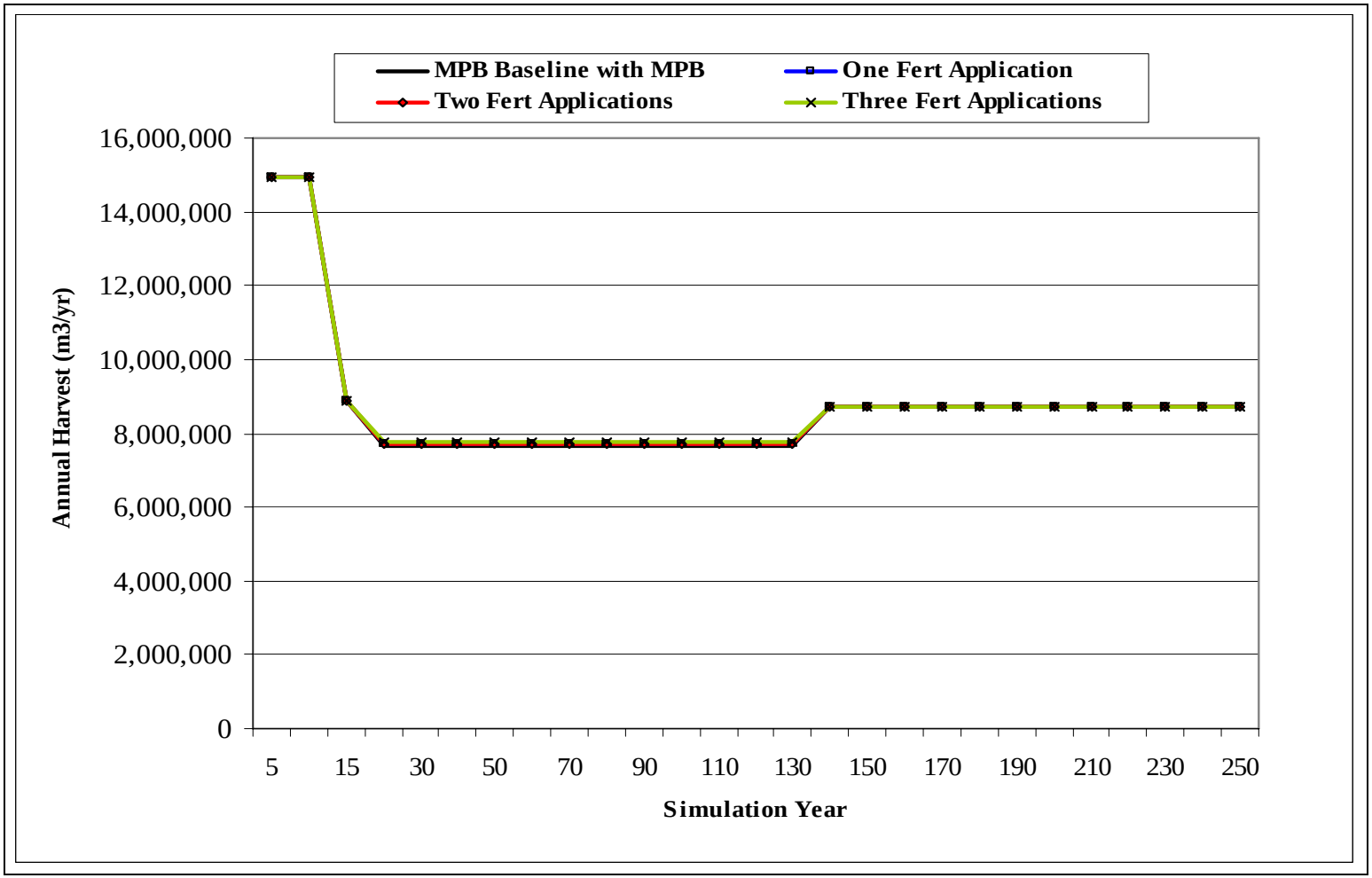

Figure 3.1 – Annual harvest levels – Prince George TSA fertilization scenarios

4.0 DISCUSSION

The Prince George TSA Fertilization analysis has reviewed the potential benefit to timber supply of treating selected Douglas-fir and spruce stands. Results of recent timber supply analyses, which modelled the impact of the MPB outbreak in the TSA suggest that a falldown in mid term timber supply is likely after the projected salvage period of 10 to 15 years is complete. The current analysis explored the extent to which fertilization might offset some of this falldown.

Approximately 260,000 hectares of fir and spruce stands were identified as candidates for fertilization treatment, 8% of the THLB. Given the data set used for the analysis, candidate stands were identified by analysis unit definition, which is simply based on leading species and site index range. A preferred method for isolating stands for treatment would use more detailed stand characteristics such as species composition, site index and site conditions. However, the based on the objectives of the analysis, the methodology is considered acceptable.

Table 4.1 summarizes the results of the analysis.

Table 4.1 – Prince George TSA fertilization analysis summary

Analysis Scenario	Stand Level Yield Improvement for Treated Stands (%)	Annual Harvest Level Improvement over COFI Baseline with MPB (m^3/year)	Annual Harvest Level Improvement over COFI Baseline with MPB (%) [1]
One Fertilization	6.9	39,000	0.5
Two Fertilizations	14.3	71,000	0.9
Three Fertilizations	24.1	114,000	1.5

[1] Improvement during mid-term (years 20 – 130) of simulation.

Results of the analysis scenarios indicate that fertilization treatments make only minor improvements to timber supply for the Prince George TSA compared with the *Baseline with MPB* scenario from the COFI analysis. This is because only a small (8%) area was included in the treatment regime.

The majority (63%) of the stands included in the fertilization treatment were less than 20 years old and therefore they only become merchantable 60 to 80 years into the future, based on minimum harvest ages modelled in the analysis. In the decades immediately following the salvage of dead and dying pine there is little treated spruce and fir available for harvest.

During year 100 of the analysis simulations there is a rupture in supply, which was observed in all scenarios modelled. This limits the harvest level during years 20 – 100 of the simulation.

The analysis indicates that given the small area included in the treatment regime and outside factors that influence mid-term timber supply, fertilization only supports a minor improvement in annual harvest.

5.0 REFERENCES

B.C. Ministry of Forests. 2001. *Prince George Timber Supply Area Analysis Report.*

B.C. Ministry of Forests. 2001. *100 Mile House Timber Supply Area Analysis Report.*

B.C. Ministry of Forests. 2004. *Expedited timber supply review for the Lakes, Prince George and Quesnel timber supply areas Public Discussion Paper.*

B.C. Ministry of Forests Forest Analysis and Inventory Branch. 2005. *Mountain Pine Beetle Analysis Project Initial Assessment of MPB on Mid-term Timber Supply of Interior TSAs.*

Canadian Forest Service and BC Forest Service. 2005. *Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMBP v2) and Results of Year 2 of the Project.*

Canadian Forest Service and BC Forest Service. 2005. *Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Executive Summary of the Year 2 Project.*

Eng, Marvin. 2005. *Presentation to the Council of Forest Industries Forestry Committee.*

Timberline Forest Inventory Consultants Ltd. 2005. *Short-Term Timber Assessment Analysis Preliminary Results Quesnel TSA.*

Timberline Forest Inventory Consultants Ltd. 2006. *Timber Supply Analysis: Mountain Pine Beetle Impact on Interior Timber Supply Areas.* Contract project for Council of Forest Industries.