TIMBER SUPPLY ANALYSIS REPORT

MANAGEMENT PLAN 4
MOUNTAIN PINE BEETLE UPLIFT

BOWRON-COTTONWOOD TREE FARM LICENCE (TFL 52 BLOCKS A AND B)

Version 2

Prepared for:
West Fraser Mills Ltd.
Quesnel, B.C.

Prepared by:
Timberline Natural Resource Group
Victoria, B.C.

Reference: 4061916.5.1
September 2007

West Fraser Timber Co. Ltd

Timberline Natural Resource Group

September 6, 2007
File: 4061916.5.1

West Fraser Mills Limited
1250 Brownmiller Road
Quesnel BC
V2J 6P5

Attention: Alan Hunter, RPF

Reference: *TFL 52 MP 4 MPB Uplift Timber Supply Analysis Report*

Dear Al,

Enclosed please find the updated *Management Plan 4 Mountain Pine Beetle Uplift Timber Supply Analysis Report* for West Fraser Mills' TFL 52. The report includes the results of the analysis scenarios modelled in support of MP 4 with the additions and updates discussed since your review of the version 2 document. Based on your instructions the report has been submitted to MoFR Forest Analysis and Inventory Branch for review.

Thank you for your input and patience during the preparation of the *Analysis Report*. Please call if you have any questions or comments related to the document or any other aspect of the analysis.

Yours truly,
TIMBERLINE NATURAL RESOURCE GROUP LTD.

Bill Kuzmuk

Bill Kuzmuk, RPF
Senior Resource Analyst

DOCUMENT HISTORY

Version Number	Description	Submission Date	Submitted By:
1	First draft	August 2007	Bill Kuzmuk
2	Second draft after review by WFM	August 2007	Bill Kuzmuk
3	Submission to MoFR after review by WFM	September 2007	Bill Kuzmuk

EXECUTIVE SUMMARY

A timber supply analysis in support of Management Plan 4 for TFL 52 has been completed. It has evaluated impacts of the MPB attack on existing pine stands and future harvest potential from the land base. A number of key elements are included in this analysis compared with previous studies done for the TFL including:

- Block B, formerly TFL 5, is now part of TFL 52, which increases the THLB by approximately 27,700 ha;
- OGMAs have been identified on the TFL which removes the old forest constraint from timber supply modelling;
- Assumptions for pine stands affected by MPB, including shelf life and residual volume in mixed stands; and
- Other non-timber interests such as conservation legacy areas and updated caribou mapping.

The analysis included updated inventory (VRI) dated and current assumptions for productive areas not available for long-term timber supply (netdowns). Yields were based on the previous management plan analyses for each block of the TFL.

The harvest schedule for all scenarios and sensitivity analyses has three distinct phases:

- Short-term, the initial 10 years during which salvage of merchantable pine is possible;
- Mid-term, years 11 to 50 when remaining natural stands and residual mixed species stands contribute to the harvest. After year 31 managed stands contribute to the annual harvest; and
- Long-term, years 51 to 250, with managed stands providing the majority of the annual harvest and the age class distribution becomes more evenly distributed.

Evaluating the timber supply and harvest flow in Woodstock, these transition points remained consistent for the various scenarios and sensitivity analyses completed.

Results indicate that it is possible to capture a large component of the dead and dying pine timber on the TFL prior to expiration of the shelf life. Setting the initial harvest at the current AAC of 692,800 m^3/year in one scenario of the Base Case recovers only 60% of the pine volume impacted by MPB, leaving over 2.95 million cubic metres unsalvaged. Increasing the initial annual harvest rate to 1.372 million cubic metres allows maximum salvage of affected pine improves recovery to over 90% with less than 650,000 cubic metres left unsalvaged.

Increasing the initial harvest rate to maximize the recovery of damaged pine timber reduces the mid-term harvest by approximately 100,000 cubic metres annually. However, the mid-term harvest is 4% higher than the current AAC for the Licence, and the overall harvest during the 250 year planning horizon is 2% higher than the Base Case scenario which used the current AAC as the initial harvest rate. The long-term harvest level is marginally higher when pine salvage is maximized due to more stands being converted to managed stands rather than being left as residual or natural regeneration.

Table E.1 summarizes the harvest levels for the alternative harvest schedules developed for the Base Case.

Table E.1 – Alternative initial harvest for Base Case

Simulation Year	Annual Harvest Rate (m^3/year)		
	Base Case	1 Million Initial	Maximize Initial
5	692,800	1,000,000	1,371,680
10	692,800	1,000,000	1,371,680
15	819,600	808,850	719,700
20	819,600	808,850	719,700
25	819,600	808,850	719,700
30	819,600	808,850	719,700
35	819,600	808,850	719,700
40	819,600	808,850	719,700
45	819,600	808,850	719,700
50	819,600	808,850	719,700
55 - 250	868,550	872,670	878,930
MPB pine non-recoverable losses	2,952,255 (39.5%)	1,157,375 (15.5%)	647,375 (8.7%)

Figure E.1 presents the results of the alternative initial harvest rate scenarios in graphic format.

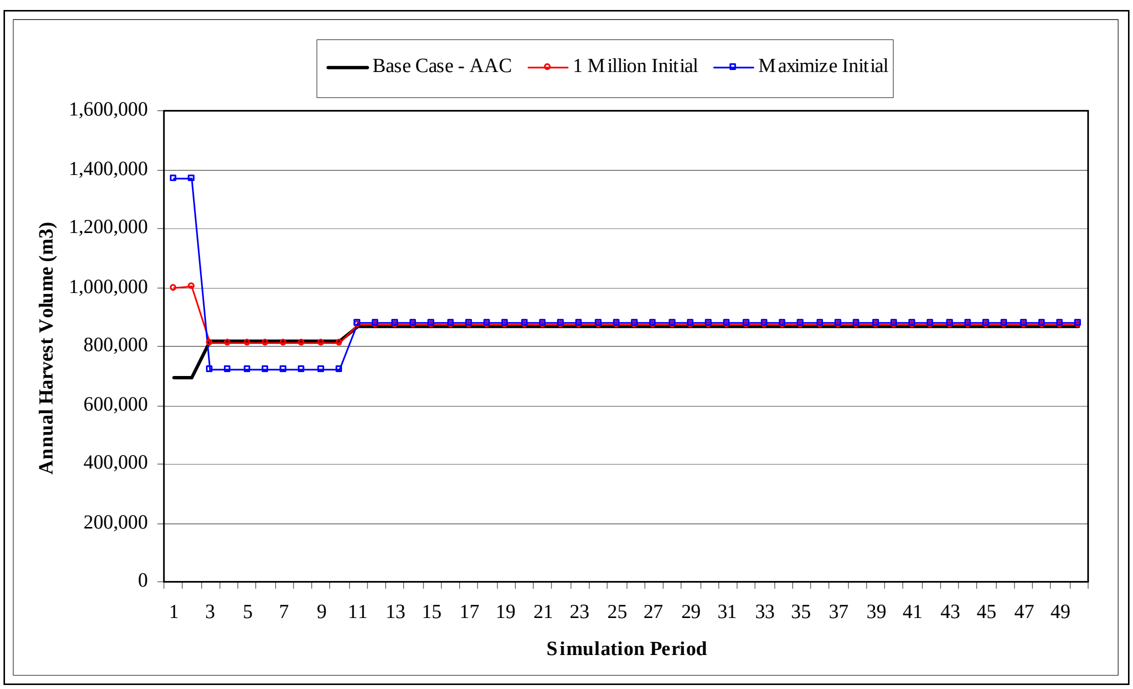

Figure E.1 –Base Case alternative harvest schedules

TFL 52 has, on average, less pine content compared with the surrounding Quesnel TSA and this benefits the TFL timber supply in two ways:

- It is possible to recover a large component of the damaged pine volume from stands with moderate to high pine content; and
- There is reasonable volume of non-pine volume remaining in the mixed species stands that are not harvested during the 10 year shelf life period.

This second aspect of the inventory is important for maintaining the harvest level above the current AAC during the period 11 to 30 years into the future prior to managed stands becoming available for harvest in year 31. The average pine content of the "low" pine stands is approximately 17%, which leaves many mixed species stands with upwards of 250 m^3/ha of residual merchantable volume after the expiration of the 10 year shelf life.

Sensitivity analysis indicates that many factors included in the analysis do not have a significant impact on the timber supply. Assumptions for shelf life and residual stand volume are especially important because they affect the time that will be available to recover damaged timber, or in cases where salvage is not possible, what volume remains in the stand. Table E.2 summarizes the results of the sensitivity analyses, which used the harvest schedule from the Maximize Initial scenario as a starting point.

The analysis for TFL 52 indicates that a considerable salvage opportunity exists on the licence and that more than 90% of the dead or dying pine volume can be salvaged if the harvest is increased over the next 10 years. If left at the current AAC only 60% of the damaged timber will be recovered. The mid-term harvest is maintained at a level above the current AAC with either level of harvest in the short term. Long-term harvest levels are projected to increase to approximately 878,000 m^3/year after 50 years.

These harvest levels are possible with all considerations for non-timber resources in place, including riparian, wildlife habitat, visual sensitivity, conservation legacy areas, and mature and old forest requirements.

Table E.3 – Summary of timber supply analysis results for TFL 52 MP 4

Analysis Scenario	Short Term (1 - 10)	% Change from Max Initial	Mid Term (11 - 50)	% Change from Max Initial	Long Term (51 - 250)	% Change from Max Initial
Base Case - Maximize Initial	1,371,680	0.0	719,700	0.0	878,930	0.0
Base Case - AAC	692,800	-49.5	819,600	13.9	868,550	-1.2
Base Case - 1 Million Initial	1,000,000	-27.1	808,850	12.4	872,670	-0.7
Base - No MPB	874,980	-36.2	874,980	21.6	874,980	-0.4
Max IHL - 5-Year Shelf	2,048,950	49.4	710,190	-1.3	880,380	0.2
Max IHL - 10-Year Shelf	1,374,860	0.2	722,990	0.5	878,860	0.0
Max IHL - 10-Year Regen Delay	1,369,460	-0.2	720,550	0.1	879,000	0.0
Max IHL - 20-Year Regen Delay	1,372,730	0.1	719,210	-0.1	878,810	0.0
Max IHL - Rehab All High	1,352,260	-1.4	727,000	1.0	879,790	0.1
Max IHL - Block B Genetics	1,343,320	-2.1	736,320	2.3	919,220	4.6
Max IHL - 50% Pl Mortality	1,367,600	-0.3	725,740	0.8	878,820	0.0
Max IHL - 100% Pl Mortality	1,368,510	-0.2	720,140	0.1	878,890	0.0
Max IHL - No Sx Target	1,347,330	-1.8	726,180	0.9	878,720	0.0
Max IHL - 350K Non-MPB	1,398,630	2.0	709,890	-1.4	879,160	0.0
Max IHL - Exclude SaRCO Caribou	1,229,920	-10.3	706,810	-1.8	854,730	-2.8
Max IHL - THLB +5%	1,429,170	4.2	731,140	1.6	902,120	2.6
Max IHL - THLB -5%	1,401,500	2.2	671,590	-6.7	840,000	-4.4
Max IHL - No Disturbance FCC	1,394,610	1.7	715,480	-0.6	879,060	0.0
Max IHL - Add Seral FCC	1,039,790	-24.2	709,370	-1.4	877,740	-0.1

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

The recent infestation of Mountain Pine Beetle (*Dendroctonus ponderosae*) (MPB) has reached critical levels throughout the interior of British Columbia including West Fraser Mills Ltd.'s (WFM) Bowron-Cottonwood Tree Farm Licence (TFL 52). Many of the adjacent timber supply areas (TSAs) have been granted increased allowable annual cut (AAC) levels to address salvage of dead and damaged timber or to provide harvesting that will reduce the spread of the beetle. The impact of this far-reaching outbreak of MPB could affect the forest for timber and other resource values.

Based on the urgency of the MPB outbreak a timber supply analysis is being conducted on TFL 52. The objective of the analysis is to provide information to the British Columbia Chief Forester to support an *uplift* to the current AAC. The uplift, which is a temporary increase in AAC, is required to allow recovery of the dead and at-risk pine volume on the TFL prior to stand breakup and complete loss of merchantable pine volume. The analysis summarizes the volume of timber at risk to attack and how adjustments in the current AAC will allow improved recovery of dead and at-risk timber. In addition, the analysis explains possible impacts of increasing current harvest rates on future timber supply.

Timber supply is the rate of timber availability for harvest over time. The methodology includes use of a forest-level simulation model, which predicts the development of a forest over a 250-year planning horizon. The model uses a description of initial forest conditions, expected patterns of growth, and a set of rules related to harvesting and regenerating the forest. In addition, management assumptions related to non-timber forest resources are included in the analysis process.

TFL 5, the MacKenzie-Cariboo Tree Farm Licence, was recently acquired by WFM as part of their purchase of Weldwood of Canada Ltd. (Weldwood). As of December 28, 2006 TFL 5 was officially merged with TFL 52 to form a single licence (TFL 52). The original TFL 52 is now called "Block A" and the old TFL 5 is referred to as "Block B". The analysis has been conducted as one management unit. However, all land base definitions and management assumptions that are unique to each area have been maintained in the analysis.

The analysis includes a "Base Case" which models current management practices and AAC levels. Alternative harvest levels have been evaluated given the circumstances caused by the MPB outbreak and the potential loss of merchantable timber. In addition, a number of sensitivity analyses have been conducted, many based on factors associated with MPB to understand how these aspects of the analysis affect timber supply on TFL 52.

Timber supply analysis involves three main steps:

- Collection and preparation of information and data. This information has been documented in the *Timber Supply Analysis Information Package Management Plan 4 Mountain Pine Beetle Uplift Bowron-Cottonwood Tree Farm Licence*, which was accepted by Ministry of Forests and Range (MoFR) Forest Analysis Branch, April 23, 2007;
- Using the data in Remsoft's spatial planning system Woodstock-Stanley simulation model (v2007.04) to develop harvest forecasts and complete sensitivity analyses; and
- Interpretation and reporting of results.

The following sections outline the TFL 52 MP No. 4 timber supply analysis.

2.0 TIMBER SUPPLY ANALYSIS PROCESS

Block A of TFL 52 is located east of Quesnel in the Quesnel Forest District. WFM was granted the TFL 52 licence in January 1991. The land base is typified by rolling plateaus in the west, and the Cariboo Mountains in the east. Numerous lakes and rivers are found within the Licence area. TFL 52 contains the headwaters of the Cottonwood, Bowron and Willow Rivers, which all flow directly into the Fraser River. Highway 26 between Quesnel and Bowron Lake Provincial Park provides primary access to Block A. This highway bisects the License into north and south components. Most forest roads into Block A originate from Highway 26. This provides excellent year-round access for both forest management and recreational activities.

Block B of TFL 52 is located northwest of Quesnel along the Fraser River. Similar to Block A the land base is typified by rolling plateaus but includes steep banks leading down to the Fraser River. Weldwood of Canada was granted the former TFL 5 licence in May 1951. Primary access to Block B is provided by Highway 97 between Quesnel and Hixon for the eastern component. The western side of Block B can be accessed by either Blackwater Road or Tako Road. Due to the long history of forestry activities on Block B, more than 50 years, there is excellent year-round access for both forest management and recreational activities.

The forests of TFL 52 are dominated by interior spruce, lodgepole pine, and Douglas-fir. Other species include subalpine fir, trembling aspen, and cottonwood. Birch, western hemlock, and western redcedar are found in localized areas. Two biogeoclimatic ecological classification (BEC) zones dominate the land base of TFL 52:

- Sub-boreal spruce (SBS), generally below 1200 metres with cool, snowy winters and warm summers; and
- Engelmann spruce-subalpine fir (ESSF), generally above 1200 metres with long, cold winters and short, cool summers.

The interior cedar-hemlock (ICH) BEC zone is found in a very small area near the eastern boundary of the TFL.

A number of communities are associated with TFL 52. These include Quesnel, Wells, Barkerville, Bowron Lake and Cottonwood. Both Wells and Barkerville are located within the License area. Two popular recreational areas, Bowron Lake Provincial Park and Troll Mountain Ski Resort, share a common boundary with TFL 52.

Figure 2.1 provides an overview map of TFL 52.

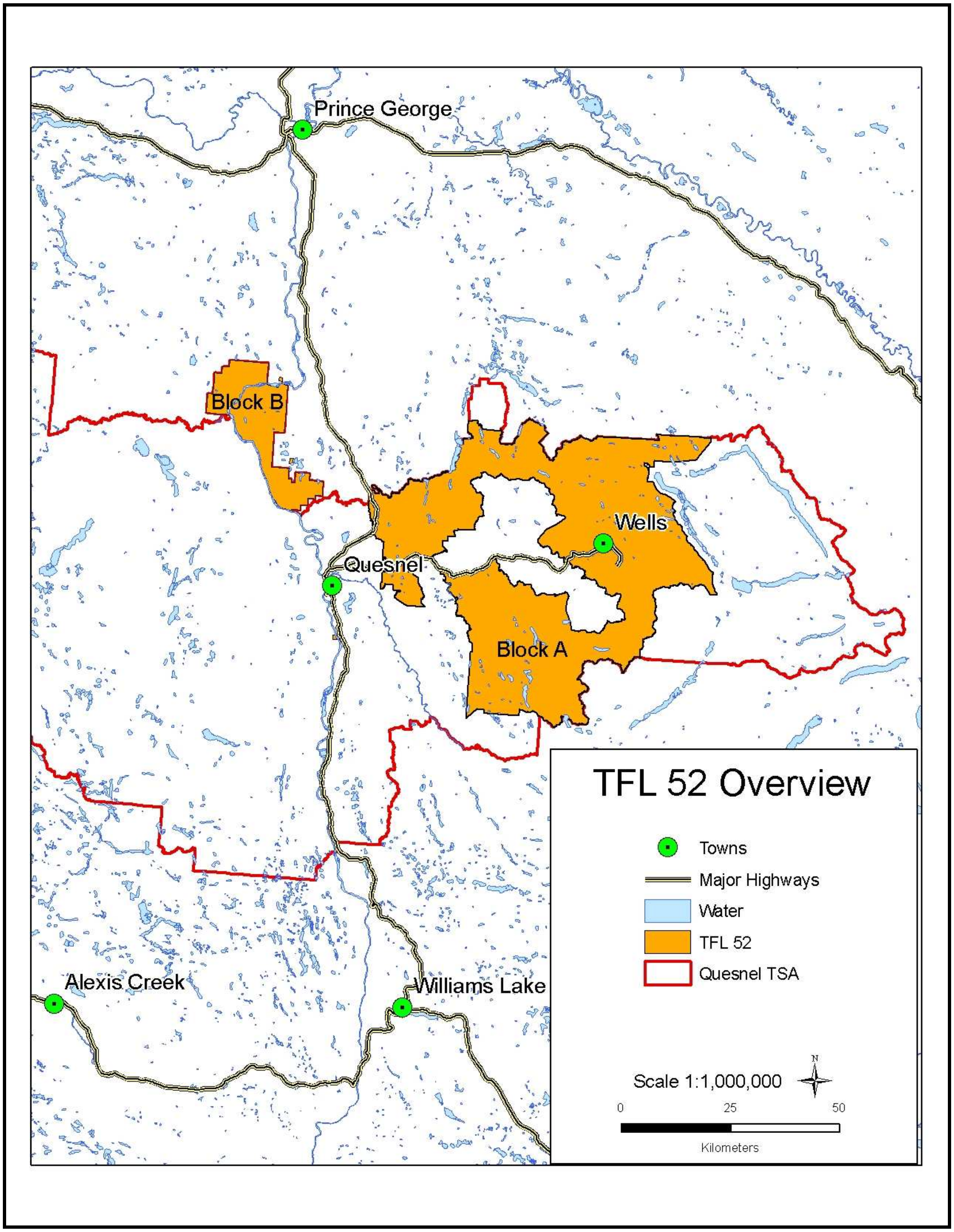

Figure 2.1 – TFL 52 overview map

3.0 INFORMATION PREPARATION

Many pieces of information are required to conduct a timber supply analysis. Each piece falls into one of three categories:

- Land base inventory;
- Timber growth and yield; or
- Management practices.

This section provides a brief overview of the information assembled for use in the timber supply analysis.

3.1 Land Base and Inventory

Land base inventory information used in this analysis comes from WFM's own digital map database, which is maintained to MoFR standards. The data is managed using ARC/INFO GIS software. The majority of the inventory data used for the MP 4 timber supply analysis was collected during the periods of Management Plans 2 and 3 (Block A) and Management Plans 9 and 10 (Block B). A complete description of the new inventories is provided in the *Information Package*.

The digital database contains information for all land within the license area, including areas on which harvesting operations are not expected to take place. The timber harvesting land base (THLB) consists of all of the productive land expected to be available for harvest over the long-term. This land base is determined by reclassifying the total land base according to specified management assumptions. Figure 3.1 provides a graphic representation of the land base reductions for the Base Case.

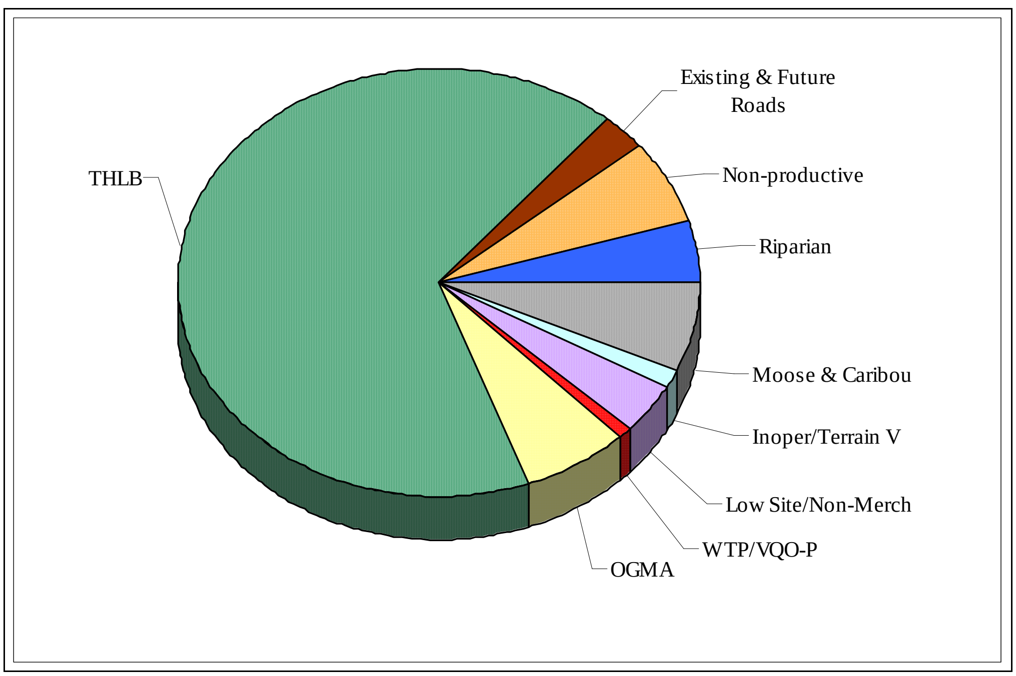

Figure 3.1 – Land base classification

Table 3.1 provides a summary of the areas removed for each land base reduction in defining the THLB.

Table 3.1 – Base Case timber harvesting land base determination

Land Classification	Total Area (ha)	Reduction		Net Remainder	
		Area (ha)	Volume (1000s m^3)	Area (ha)	Volume (1000s m^3)
Total area	**293,485**			**293,485**	**48,865.5**
Non-productive, non-forest		18,521	3.0		
Existing roads		4,749	468.0		
Productive forest				**270,215**	**48,394.5**
Non-commercial brush		221	0.2		
Riparian reserve zones		7,406	1,764.0		
Riparian management zones		6,182	1,400.4		
Moose & Caribou no-harvest		19,941	3,754.3		
Inoperable & terrain class V		3,833	865.2		
Low productivity		2,969	430.3		
Deciduous		3,297	138.5		
Non-merchantable		5,291	171.8		
Preservation VQO		87	23.8		
Wildlife tree patches (WTP)		2,146	616.1		
OGMA		19,467	5,387.4		
Total productive reductions		**70,839**	**14,552.0**		
Current THLB				**199,376**	**33,842.5**
less future roads		3,800	659.8		
Long-term THLB				**195,576**	**33,182.7**

Figure 3.2 summarizes the current age class distribution by leading species. Note that minor areas (< 100 ha) of western redcedar and western hemlock are included with Douglas-fir.

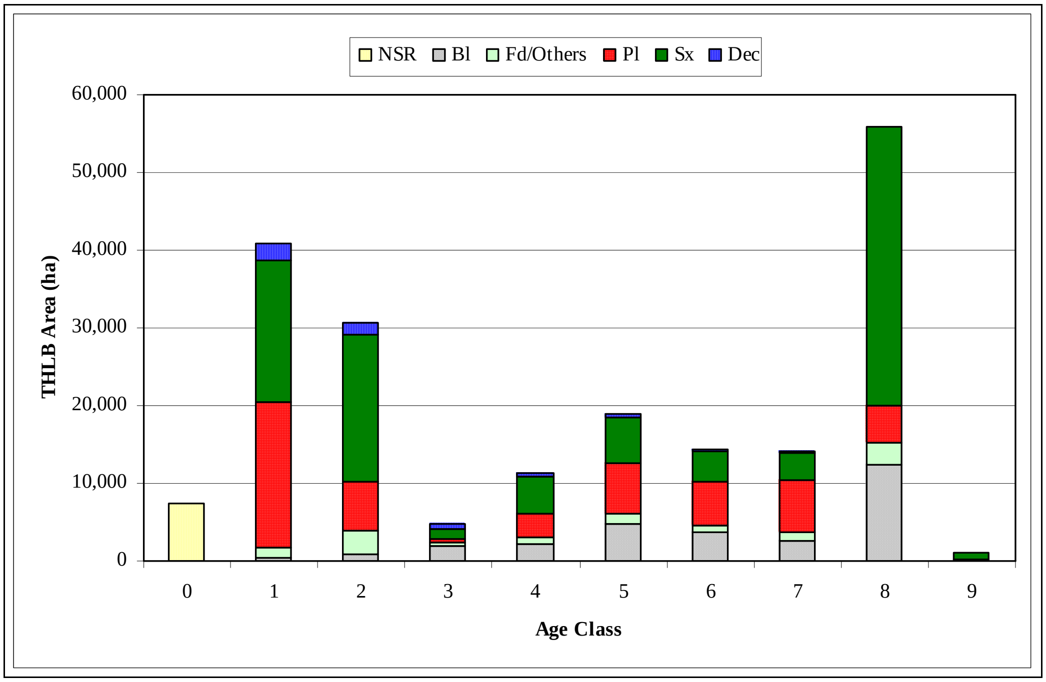

Figure 3.2 – THLB leading species and age class distribution

3.2 Timber Growth and Yield

VDYP (Version 6.4a) was used to develop natural stand yields at the analysis unit level. A yield table was first generated for each stand. These yield tables were then "clustered" (based on area weighting) to produce one yield function for each analysis unit, as described in the reports *Yield Table Summary Report, West Fraser Mills TFL 52 Quesnel* (JS Thrower & Associates, 2000) and *Yield Tables for Natural and Managed Stands: Management Plan 10 on TFL 5* (JS Thrower & Associates, 2002).

Due to the large number of analysis units, and associated yield tables produced for the management plan analyses, these yield tables were further aggregated for the MP 4 analysis. JS Thrower & Associates used the original source data for each TFL block to prepare new yield tables. The result is 50 natural stand yield tables for each block with a duplicated set for post-MPB attack stands (not harvested within the shelf life period).

Existing and future managed stand yields were developed using MoFR BatchTIPSY (Version 2.5r). As with the VDYP natural stand yields, the managed stand yields were aggregated into two sets of 50 (one for each block of the TFL).

Table 3.2 summarizes the average productivity estimates for the yields used in this analysis. The long-run sustained yield (LRSY) estimate for each yield type is for the entire THLB (199,376 ha).

Table 3.2 – Theoretical LRSY estimate

Yield Type	Average Culmination MAI (m3/ha/year)	Weighted Average Culmination Age	Theoretical LRSY (m3/year)
Natural stands	2.92	86	582,400
Managed stands	4.87	62	970,400

In the analysis, 95% of culmination age was used as the basis for minimum harvest age for all clearcut stands. Caribou selection harvest areas used a planned rotation of 240 years with entries every 80 years. In the selection harvest area, 33% of the mature volume was available for harvest during each entry.

3.3 Management Practices

Timber supply is directly linked to forest management activities. Current practices are modelled by matching inputs to actual activity using the functionality in the timber supply model. Forest cover constraints were modelled for the following:

- Resource emphasis areas (REA) including visual quality and wildlife habitat areas;
- Landscape level biodiversity (mature plus old forest constraints) based on the requirements outlined for each landscape unit BEC variant in the THLB and non-THLB components of the TFL; and
- Conservation legacy areas (CLA) which have an old forest requirement assigned.

In order to model landscape level biodiversity objectives (seral or old forest constraints) the land base was assigned to units based on landscape unit, BEC (variant) and natural disturbance type using the TFL 52 BEC mapping.

It is important to note that Core mule deer areas along the Fraser River in Block B are only available for salvage of damaged timber based on past requirements. Otherwise these areas are not available for harvesting.

A complete list of the REAs and landscape unit-BEC units modelled in the analysis are provided in the *Information Package*.

4.0 Analysis Methods

4.1 Forest Estate Model

The TFL 52 MP 4 Timber Supply Analysis used Remsoft's spatial planning system Woodstock–Stanley (www.remsoft.com). Woodstock is the aspatial component of the suite and addresses the majority of the model objectives and constraints. Woodstock performs a similar function as the MoFR's FSSIM model whereby management zones and constraints are defined, and yield curves are incorporated and applied to an aggregated area file. The primary difference between Woodstock and FSSIM is that Woodstock is capable of using either optimization or sequential simulation in developing a harvest forecast.

Stanley, the spatial component of the suite, applies the Woodstock harvest forecast to specific polygons on the land base. Stanley will aggregate individual polygons into suitable harvest units (blocks) based on specified minimum, maximum, and target block sizes. The model will also enforce green-up and adjacency requirements as it schedules the harvest spatially.

The model used five-year planning periods and was run for a 250-year planning horizon. For the base case the pre-uplift AAC for each block of the TFL was used as a starting point and was maintained as long as necessary to recover dead and at-risk pine. As managed stands become harvestable, a long-term harvest level was established that maintains a stable growing stock level over the long-term.

4.2 Harvest Flow Objectives

A number of different harvest flows have been explored, based on alternative priorities for harvesting dead and at-risk pine timber. In many analysis simulations, forest cover constraints and biological capacity of the THLB dictate timber availability and harvest level options.

Due to the circumstances associated with the MPB outbreak, conventional objectives related to harvest flow might not apply in all analysis scenarios. However, wherever possible harvest flow will reflect the following objectives:

- Recover the maximum volume of dead and at-risk pine volume prior to loss of merchantability;
- After the uplift period, maintain or increase the current AAC for as long as possible;
- Limit changes in harvest level to less than 10% of the level prior to the reduction; and
- Achieve stability in the long-term harvest level and growing stock profiles.

It is important to evaluate the impact of beetle attack, and potential changes to short-term harvest levels on the TFL, and on mid-term timber supply approximately 20 to 60 years into the future. This is expected to be the period when timber supply will be most affected by the MPB infestation.

The initial harvest level was focused on pine stands that have been or are expected to be attacked by MPB. Three priority levels of pine stands have been identified in the inventory based on pine content. Table 4.1 summarizes the characteristics of the three pine categories. Note that the conifer volume reflects all volume present in these stands regardless of species.

Table 4.1 – Pine stand priority characteristics

Category	Pine Content & Average (%)	THLB Area (ha)	Pine Volume (m^3)	Conifer Volume (m^3)
High	> 50 (72)	27,862	6,110,968	8,487,455
Medium	30 – 50 (40)	2,309	222,083	555,207
Low	< 30 (17.5)	31,247	1,134,237	6,481,356
Total		61,418	7,467,288	15,524,018

Note the volumes listed in Table 4.1 are taken from the analysis results and will therefore vary from some of the values provided in the *Information Package*.

In addition to targeting pine stands for harvest during the first 10 years of simulation, 700,000 cubic metres (140,000 m^3/year) of stands with at least 65% spruce are also given high priority in the first 5 years. These stands are considered high risk to attack by spruce beetle. This reflects current and expected spruce beetle attack levels during the next five years.

4.3 Presentation of Results

Analysis results are provided in both tabular and graphic format for all scenarios modelled. Non-recoverable losses of 2,470 m^3/year were included in the harvest request during modelling but are not reported in the volumes presented in the report.

For the key analysis scenarios, namely the Base Case, 1-Million Initial and the Maximum Initial, a complete set of analysis results are provided, including:

- Growing stock (inventory) levels;
- Distribution of harvest between TFL Blocks;
- Distribution of harvest across stand types;
- Characteristics of stands harvested; and
- Recovery of at-risk pine volume and residual pine volume losses.

For the remaining analysis scenarios, the annual harvest levels are provided with comparison to the Base Case and Maximum Initial Harvest Level results.

5.0 BASE CASE RESULTS

5.1 Current AAC Initial Harvest

A number of alternative harvest levels were modelled during the initial 10 years of simulation. The Base Case reflects current management on the TFL and therefore it uses the AAC for the licence, without any uplift volume. In this scenario the short-term harvest was set at 692,800 m^3/year. Table 5.1 summarizes the annual harvest rates for the MP 4 Base Case, including contribution from each pine priority class. Non-recoverable loss estimates are based on the total pine volume of 7,467,288 cubic metres listed in Table 4.1

Table 5.1 – Base Case annual harvest

Simulation Year	Annual Harvest Rate (m^3/year)			
	Low Priority	Medium Priority	High Priority	Total TFL 52
5	4,466	40	397,952	692,800
10	12	12	500,524	692,800
15				819,600
20				819,600
25				819,600
30				819,600
35				819,600
40				819,600
45				819,600
50				819,600
55 - 250				868,550
MPB pine non-recoverable losses	1,111,845	221,822	1,618,588	2,952,255 (39.5%)

The initial harvest rate is maintained for 10 years at the current AAC followed by a 19% increase in year 11 of the simulation. A further increase of 6% to the long-term harvest level (LTHL) is possible in year 55 for the remainder of the 250-year planning horizon. No mid-term decline in harvest is caused by the MPB attack based on the assumptions used in the Base Case.

High priority stands contribute most of the volume from stands affected by MPB. The model will always attempt to recover volume from high priority stands. If these stands are not salvaged prior to the end of the assumed shelf life there is no residual volume that can be harvested in the next few periods. Low and medium priority stands have residual volume from other species and therefore can support the harvest immediately in year 11 and onwards.

Based on the initial inventory of pine affected by the MPB, there is a total of more than 2.95 million cubic metres of volume lost at the end of the 10-year shelf life based on the assumptions of the Base Case.

As noted in Section 4.2, 700,000 cubic metres of high priority spruce is harvested during the first five years of the planning horizon.

Figure 5.1 presents the Base Case harvest level showing the distribution between Blocks A and B of the TFL. A scenario was modelled in which all MPB attack, shelf life, and residual volume assumptions were excluded. The results of this simulation are also included in Figure 5.1 to demonstrate the impact of MPB on the potential harvest from TFL 52.

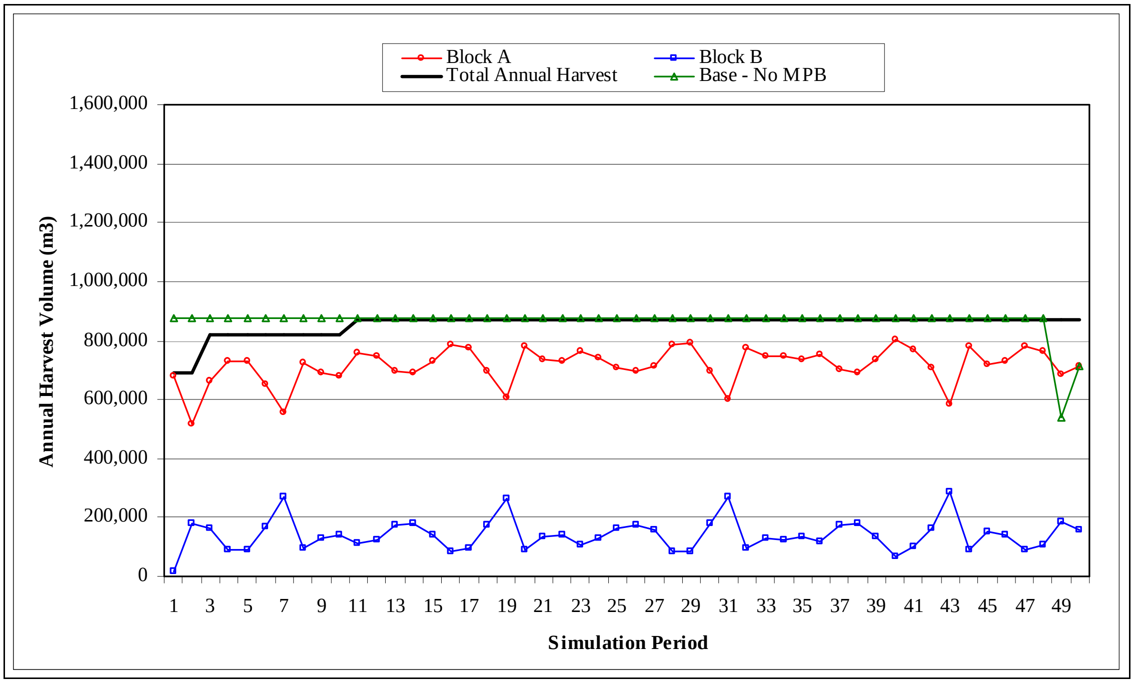

Figure 5.1 – Base Case annual harvest

There is considerable fluctuation in the harvest level on Block B, with very little harvest in the initial five years. This indicates that higher priority salvaged opportunities exist on Block A. In addition, all the stands affected by MPB on Block B have been assigned a 10-year shelf life based on site characteristics. This allows harvesting to focus on Block A during the initial five years of simulation. Managed stands on Block B are up to 56 years old based on a longer history of activity on that portion of the TFL. These stands begin contributing to the harvest in period seven of the simulation after reaching minimum harvest age. In the long term there is a spike in harvest on Block B every 60 years as managed stands accumulate and become available at or near the defined minimum harvest age.

The potential harvest in the absence of MPB is 874,980 m^3/year, indicating that the mid-term harvest is reduced by approximately 55,380 m^3/year. The initial harvest rate is not at its full capacity as described in Section 5.2, so the reduction in short-term harvest is not a factor of the MPB attack. The difference between the long-term harvest rates is less than 1% for the Base Case and Base No-MPB, which is insignificant.

Figure 5.2 displays the growing stock levels over time for the Base Case.

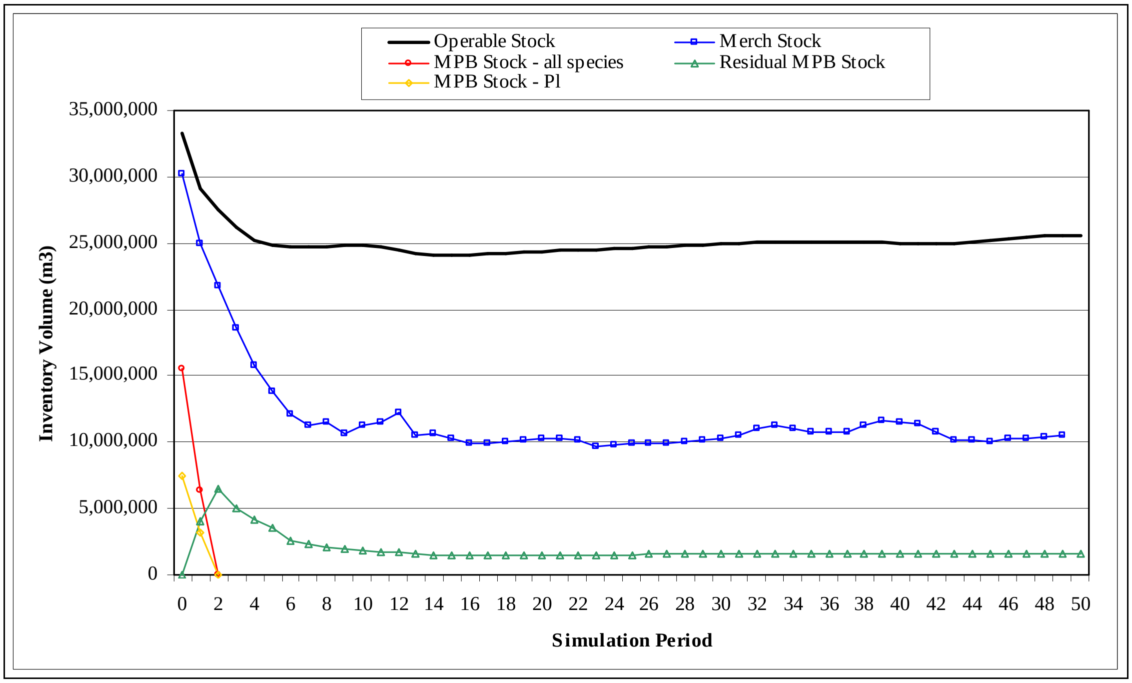

Figure 5.2 – Base Case growing stock

After the initial decline and transition to second growth harvesting, the total growing stock on the TFL is stable at approximately 25 million cubic metres. Similarly the merchantable growing stock is constant at about 10 million cubic metres. This indicates that the timber supply is stable under the assumptions for the Base Case.

Residual MPB volume, which represents the non-pine species in the low and medium priority groups, is approximately 6.5 million cubic metres at the end of the 10-year shelf life for attacked pine. This volume plays a significant role in supporting the harvest during the next 30 to 40 years when managed stands become available for harvesting. This illustrates that the timber supply on TFL 52 is quite different from the adjacent Quesnel TSA. The lower pine content on the TFL and higher residual volume of non-pine species can support the mid-term harvest. Conversely, on the Quesnel TSA, the residual volume of non-pine species is significantly lower which limits the timber supply after the shelf life for pine salvage has ended in approximately 10 years.

Figure 5.3 displays the age class distribution for TFL 52 at selected times during the 250-year planning horizon.

Figure 5.3 – Base Case age class distributions at selected periods

As shown in Figure 5.3 there is a considerable area, across many ages, affected by MPB on the TFL. These stands are assumed to lose most or all of the pine volume after the shelf life expires in five to 10 years. This loss of volume, combined with the lack of inventory currently between ages 40 and 65 limits the harvest in the mid-term after the MPB attack has ended.

After 10 years, all pine stands, which were at least 35 years old at the start of the simulation, have either been harvested and replanted or have only the non-pine volume remaining. The grey areas at years 10 and beyond represent the residual stands which were not harvested and have lost pine volume. These areas correspond to the red bars in the current age class distribution with appropriate reductions for harvest during the first 10 years of simulation. However, because these stands still have reasonable volumes they support the harvest prior to managed stands becoming available at year 35 of the simulation.

As the simulation progresses and harvesting and ageing of stands, there is more even distribution of the younger age classes after year 50. Many of the mature stands not affected by MPB have been harvested, but some remain to accommodate non-timber objectives for habitat, seral, and conservation legacy areas.

By the end of the 100 years most of the THLB has been converted to managed stands and there is only a minor component of that forest area older than 100 years. Similarly at the end of the 250-year planning horizon all of the non-THLB has aged to an overmature condition. A small component of MPB residual area is also retained and has aged to 250 years of age. The THLB is evenly distributed across the younger age classes.

Figure 5.4 presents the distribution of the periodic harvest over the planning horizon.

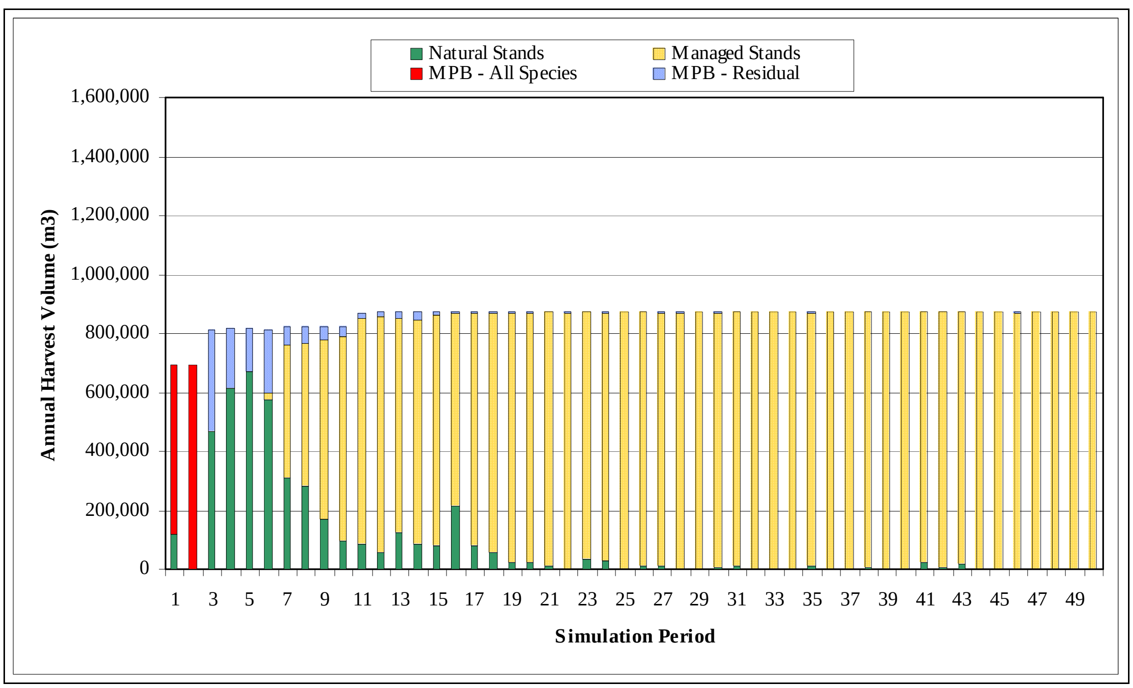

Figure 5.4 – Base Case harvest distribution by stand type

During the first 10 years the majority of the harvest is in stands affected by MPB. However, approximately 35% of this harvest includes non-pine species in mixed stands. The residual harvest in periods three to six shows the important role of these stands. Managed stands do not contribute significantly until year 36 (period seven) of the simulation and increase in contribution for the remainder of the planning horizon. The managed stands included in the harvest during period seven are mainly from Block B. Natural stands contributing to the harvest in the long term are those areas that were held in temporary reserve to accommodate habitat and seral requirements during the first 50 years of simulation.

Figure 5.5 presents the average harvest area from each block of the TFL and from MPB areas.

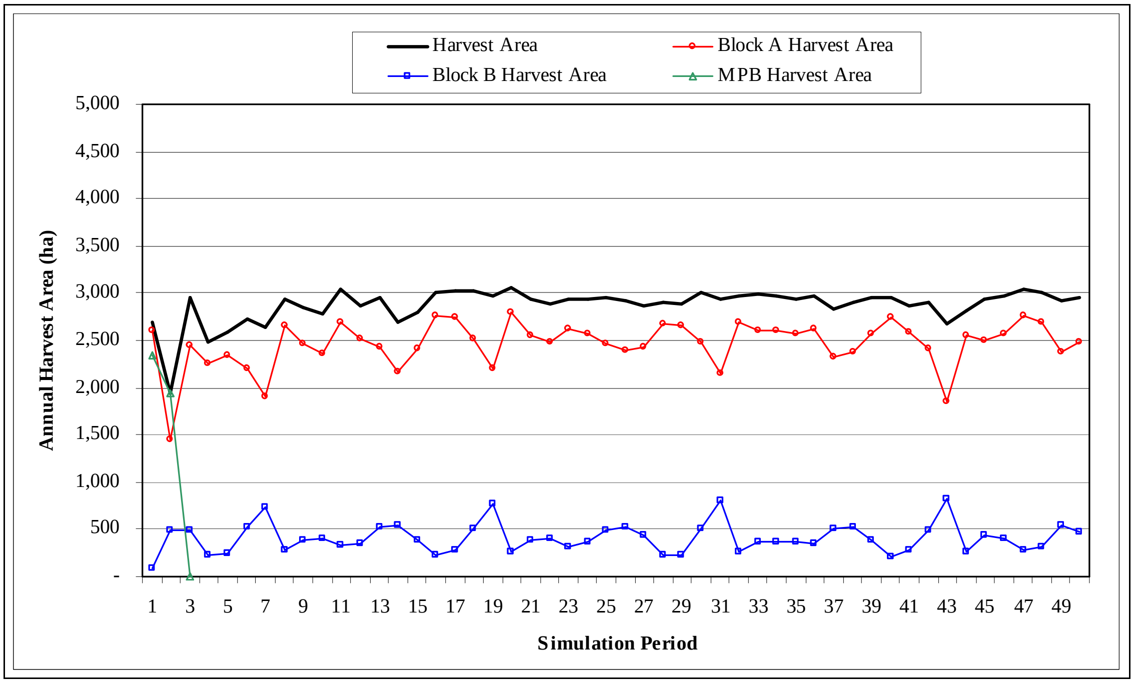

Figure 5.5 – Base Case harvest area

The areas harvested from each block of the TFL coincide with the volumes obtained over time, with similar peaks and valleys as shown in Figure 5.1. MPB harvest areas are defined as those areas salvaged during the first 10 years of simulation and therefore become zero in period three and beyond. Figure 5.6 shows the average harvest attributes for the Base Case.

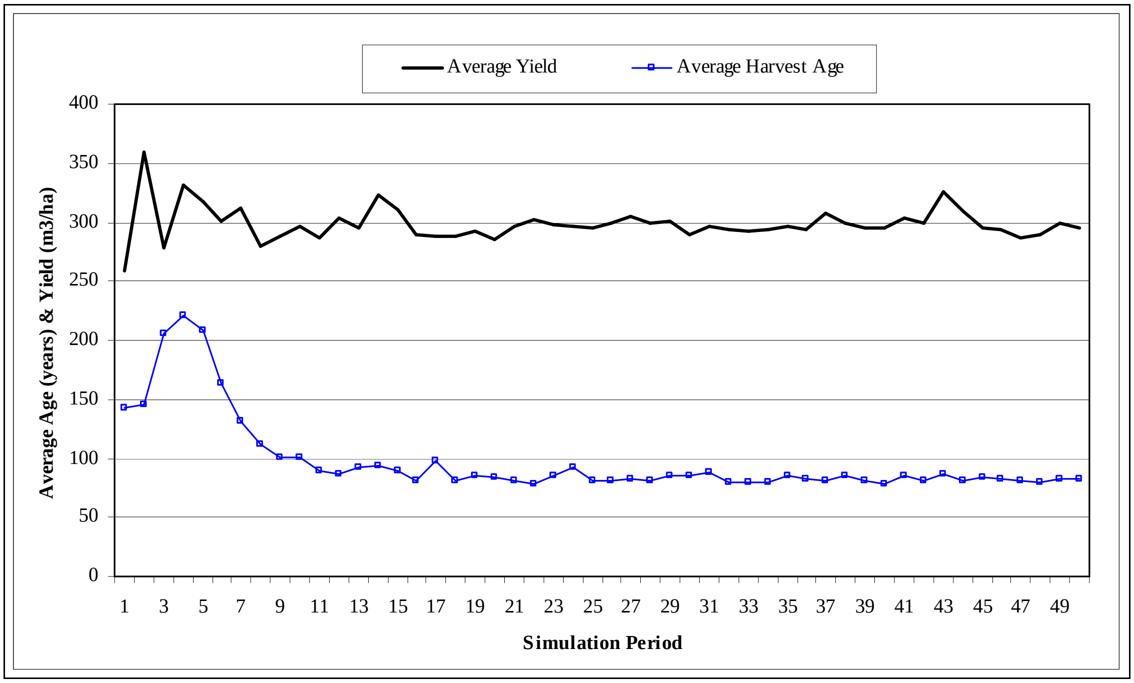

Figure 5.6 – Base Case average harvest attributes

Average yield is highest during the second period (years six through 10). It is at this time that high priority pine stands dominate the harvest profile. These areas are on moist sites which typically produce better pine volumes than the wet sites harvested during the first period. Over the long term volumes are approximately 300 m^3/ha.

Average age peaks in period four after the MPB salvage is complete. Pine stands are not the oldest on the TFL and therefore as the residual areas and natural stands of other species are harvested the average age increases. As managed stands contribute to the majority of the harvest in year 36 and beyond the average harvest age drops to between 80 and 90 years in the long term.

5.1.1 Status of Non-Timber Forest Cover Objectives

The following set of figures summarizes the state of the forest with respect to the various non-timber objectives or forest cover constraints. In each summary figure the maximum disturbance or minimum mature/old forest requirement is provided along with the status of disturbance or mature/old for the cover objective at each period modelled in the analysis.

Figures 5.7 through 5.10 display the disturbance objectives modelled for green-up, visual quality objectives and wildlife habitat.

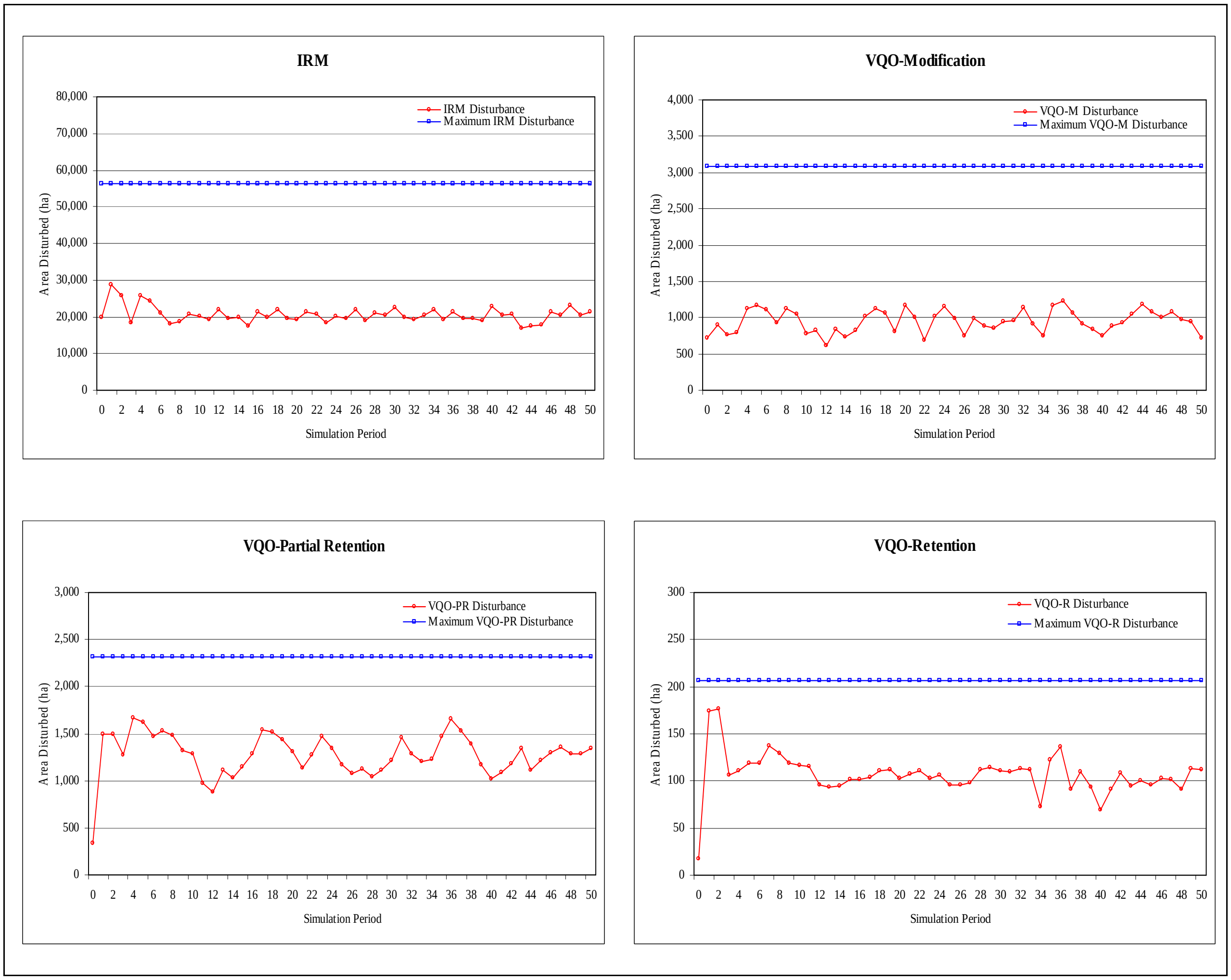

Figure 5.7 – Base Case IRM and VQO disturbance status

As shown in Figure 5.7 none of the IRM or VQO aggregated areas are in violation at any time during the 250-year planning horizon. A minor area of VQOs, less than 1% of the productive forest land base, is in violation of the prescribed constraint at the beginning of the simulation. However, within 10 years, these areas have grown out of the constraint condition allowing harvesting to continue. This violation is a result of modelling each VQO polygon individually (279 in total). In general, harvesting is not limited by disturbance constraints associated with these REA types.

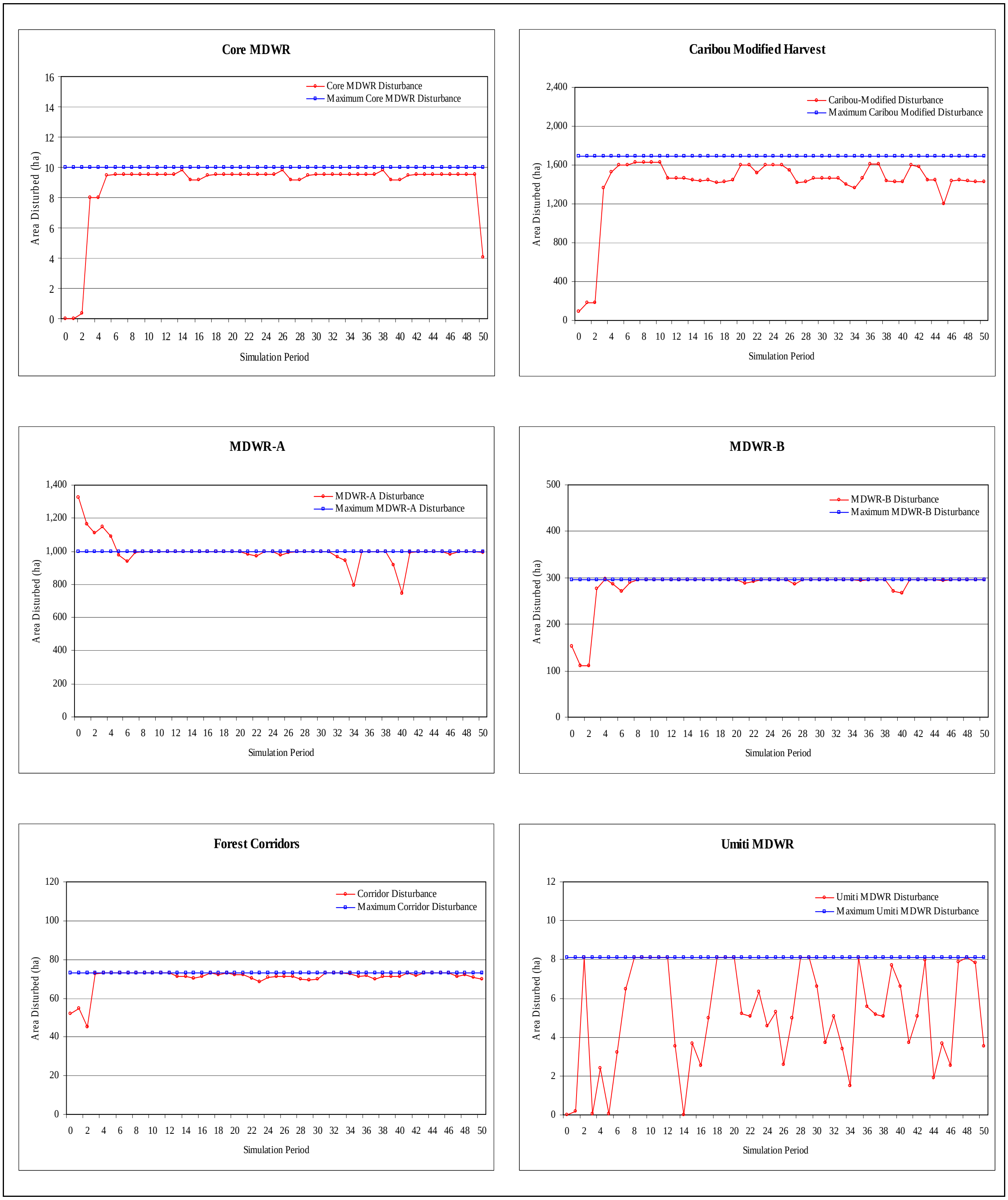

Figure 5.8 – Base Case habitat disturbance status

Disturbance constraints associated with wildlife objectives on the TFL are at, or near the limit more frequently during the simulation. The constraints associated with wildlife affect a much smaller area of the TFL compared with IRM and VQO constraints. In addition, the constraints assigned to wildlife areas are typically more restrictive based on habitat requirements, thereby limiting harvest more often.

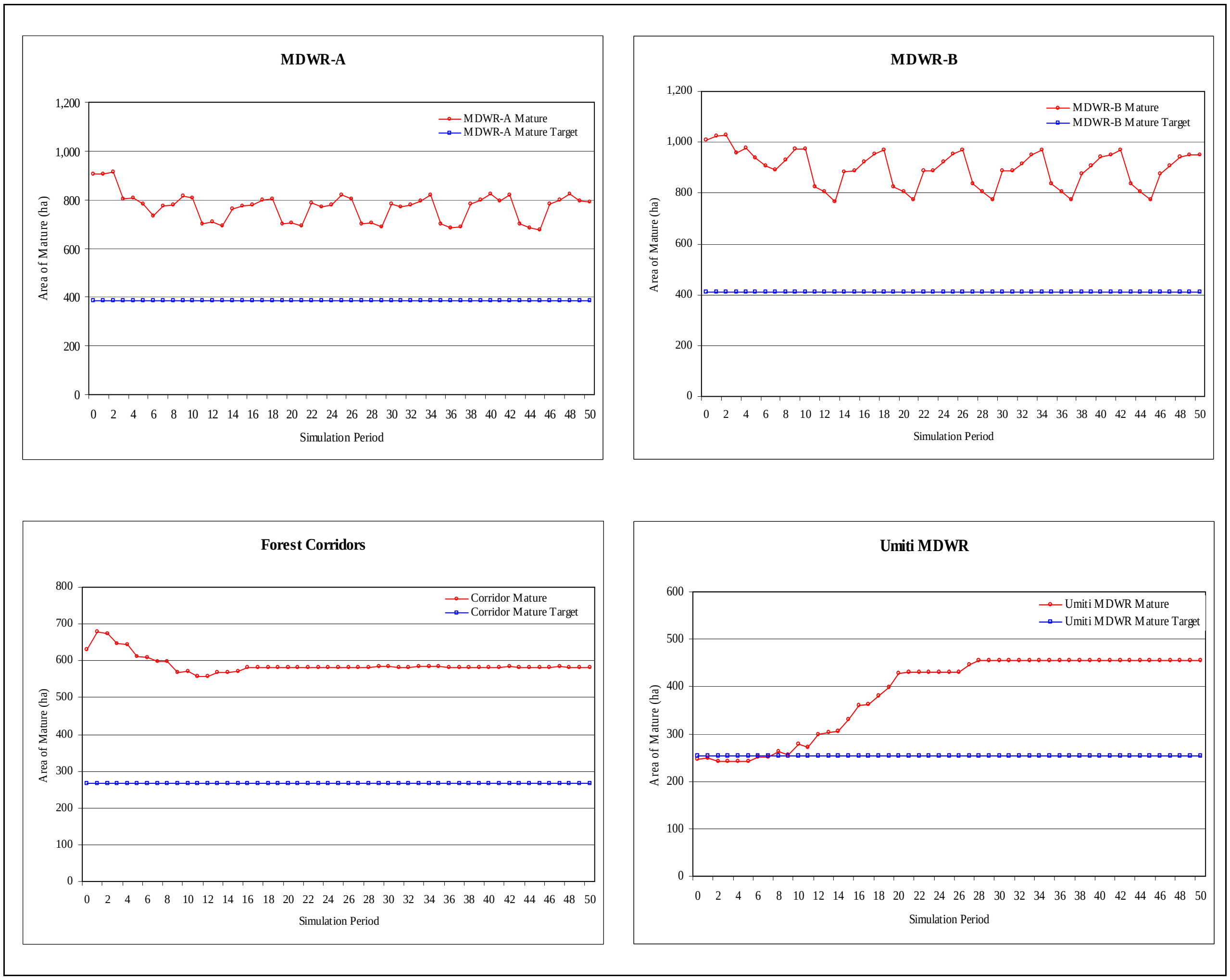

Figure 5.9 – Base Case habitat mature forest status

Mature retention for thermal cover and other associated wildlife objectives do not limit harvesting for the majority of the planning horizon. In the Umiti MDWR area of Block A, there is initially a lack of sufficient forest in stands older than 140 years but this MDWR area occupies only 500 ha of the TFL so it does not play an important role in determining timber supply for the land base.

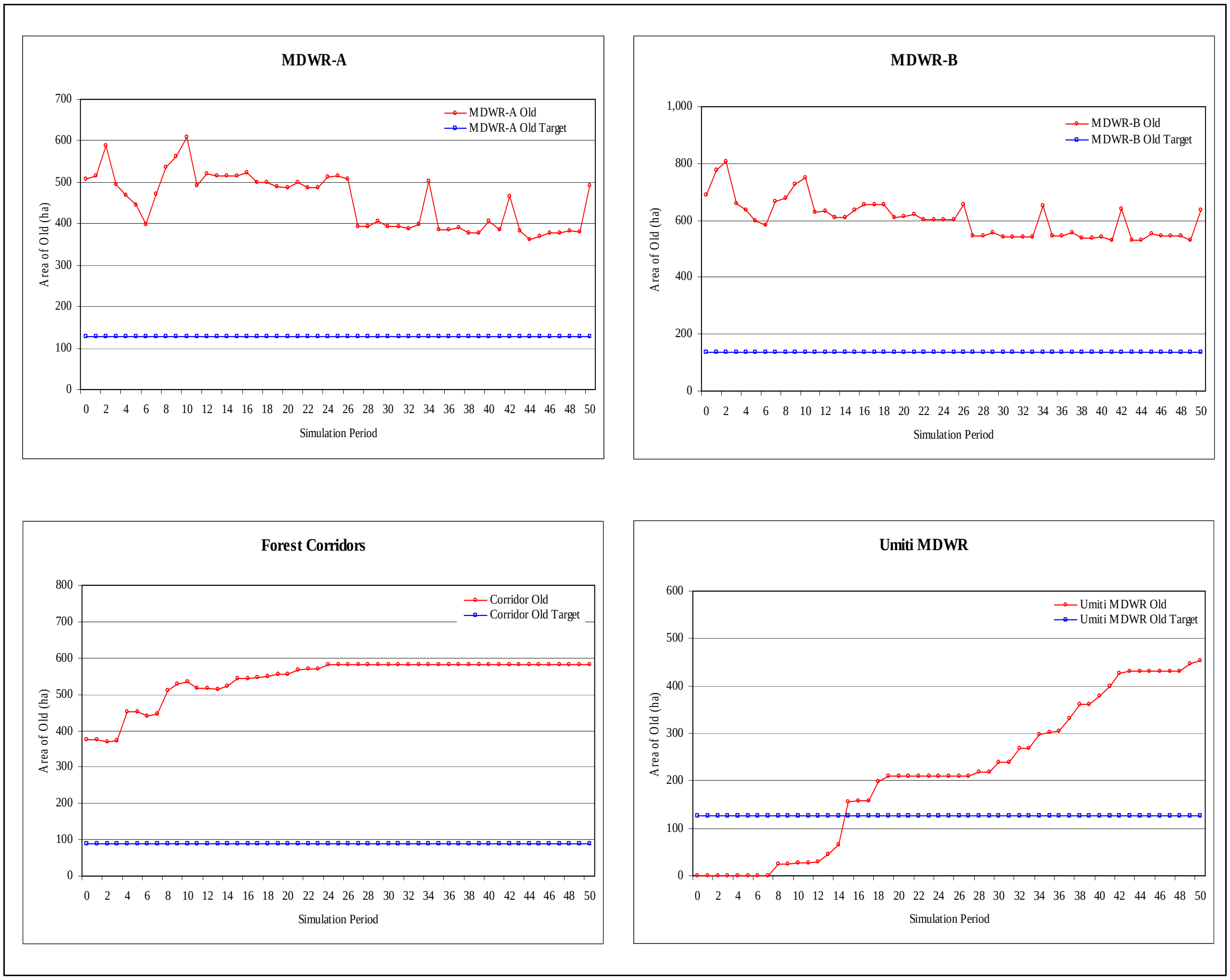

Figure 5.10 – Base Case habitat old forest status

Similar to the mature forest cover requirements, old forest cover requirements for wildlife habitat do not play an important role in establishing a harvest level for the TFL. There is sufficient old timber on the productive and THLB to accommodate the prescribed objectives. The removal of large areas for riparian and OGMAs contribute to the old forest objectives for wildlife. There is an initial shortfall in the Umiti MDWR area, which recovers 60 years into the future. As previously noted this affects only 500 ha of the TFL and therefore does not have an impact on timber supply.

Tables 5.2 and 5.3 summarize the state of the forest with respect to mature plus old forest cover requirements associated with conservation legacy areas and LUBEC-NDTs aggregates identified on the TFL.

In addition, Table 5.4 summarizes the old seral forest condition for each LUBEC-NDTs aggregate. However, forest cover constraints were not explicitly modelled for this objective because permanent OGMAs have been identified on the land base and removed from the THLB.

Table 5.2 – Old forest status for CLAs at specified periods

Conservation Legacy Area & Analysis ID		Productive Area (ha)	THLB Area (ha)	Target Area (ha)	Current Area (ha)	Area Older than Target at Specified Periods			
						20 Years	50 Years	100 Years	250 Years
331	Umiti-ESSFwc3-CLA	71	71	11	15	14	11	62	11
332	Umiti-ESSFwk1-CLA	195	185	31	1,450	955	495	492	483
333	Umiti-SBSdw1-CLA	550	411	88	429	285	88	96	88
334	Umiti-SBSmw-CLA	10,977	9,443	1,756	1,898	2,770	1,756	1,756	1,756
335	Umiti-SBSwk1-CLA	1,705	1,548	273	1,071	1,135	1,091	992	992
336	Victoria-ESSFwc3-CLA	12	12	2	1,079	888	129	129	451
337	Victoria-ESSFwk1-CLA	886	768	115	3,241	2,615	1,361	1,356	1,332
338	Victoria-SBSmw-CLA	11,563	9,470	1,503	8,158	1,959	1,932	1,713	1,713
339	Victoria-SBSwk1-CLA	7,773	6,654	1,011	6,891	4,313	4,450	4,374	4,374

Table 5.3 – Mature plus old forest status for LUBECs at specified periods

LUBEC-NDT & Analysis ID		Productive Area (ha)	THLB Area (ha)	Target Area (ha)	Current Area (ha)	Area Older than Target at Specified Periods			
						20 Years	50 Years	100 Years	250 Years
11	Antler-ESSFwc3-1	12,005	1,884	4,322	7,599	8,288	9,532	9,951	9,923
12	Antler-ESSFwk1-1	15,332	11,711	5,519	6,240	6,834	5,519	5,519	5,519
13	Antler-SBSwk1-2	14,508	10,848	4,498	7,558	4,631	4,498	4,498	4,498
16	Big-Valley-SBSwk1-2	5,858	4,587	879	3,107	1,503	1,154	1,273	1,271
19	Bowron-ICHmk3-2	1,086	1,002	163	262	167	163	163	163
20	Bowron-ICHwk4-1	442	388	75	200	75	75	75	75
21	Bowron-SBSwk1-2	2,320	2,043	348	610	348	384	348	348
24	Indianpoint-SBSwk1-2	9,606	8,667	1,441	4,272	1,876	1,441	1,441	1,441
27	JackofClubs-SBSwk1-2	1,900	1,297	285	1,199	817	679	603	603
31	Lightning-SBSwk1-2	9,320	7,620	1,398	3,994	2,166	1,546	1,702	1,700
34	Swift-SBSwk1-2	6,893	5,860	1,034	2,750	1,597	1,034	1,034	1,034
35	Umiti-ESSFwc3-1	392	168	141	240	238	236	224	236
36	Umiti-ESSFwk1-1	2,976	2,379	1,071	1,998	1,492	1,071	1,071	1,071
37	Umiti-SBSdw1-3	1,619	924	372	782	912	750	791	783
39	Umiti-SBSmw-3	26,005	20,003	5,981	3,618	5,981	6,622	7,760	7,761
40	Umiti-SBSwk1-2	5,794	4,980	1,796	1,469	1,670	1,796	1,796	1,796
41	Victoria-ESSFwc3-1	2,095	1,079	1,131	2,082	1,891	1,131	1,131	1,131
42	Victoria-ESSFwk1-1	6,127	4,151	3,308	4,981	4,529	3,308	3,308	3,308
43	Victoria-SBSmw-3	18,566	13,960	6,312	12,389	6,312	6,312	6,312	6,312
44	Victoria-SBSwk1-2	16,878	13,489	7,764	9,684	7,372	7,614	7,764	7,764
48	Willow-SBSwk1-2	11,663	9,613	1,750	4,530	2,393	1,761	2,068	2,079

Table 5.4 – Old forest status for LUBECs at specified periods

LUBEC-NDT & Analysis ID		Productive Area (ha)	THLB Area (ha)	Target Area (ha)	Current Area (ha)	Area Older than Target at Specified Periods			
						20 Years	50 Years	100 Years	250 Years
1	Ahbau-SBSmh-3	6,511	3,836	716	2,464	2,569	2,863	3,420	3,438
2	Ahbau-SBSmhmw-3	1,153	1,005	127	83	28	101	207	148
3	Ahbau-SBSmw-3	24,985	22,873	2,748	2,877	2,215	1,580	1,959	2,346
11	Antler-ESSFwc3-1	12,005	1,884	2,281	143	548	2,314	5,139	9,914
12	Antler-ESSFwk1-1	15,332	11,711	2,913	146	402	399	1,421	5,485
13	Antler-SBSwk1-2	14,508	10,848	1,306	193	157	264	1,029	4,299
14	Big-Valley-ESSFwc3-1	2,979	1,842	566	38	7	136	681	1,132
15	Big-Valley-ESSFwk1-1	9,405	7,660	1,787	87	93	679	1,219	1,739
16	Big-Valley-SBSwk1-2	5,858	4,587	527	41	41	485	843	1,271
17	Bowron-ESSFwc3-1	1,282	75	244	0	1	27	300	1,073
18	Bowron-ESSFwk1-1	2,323	1,929	441	49	35	58	191	394
19	Bowron-ICHmk3-2	1,086	1,002	98	57	36	125	61	162
20	Bowron-ICHwk4-1	442	388	40	70	37	53	53	72
21	Bowron-SBSwk1-2	2,320	2,043	209	100	22	3	36	334
22	Indianpoint-ESSFwc3-1	169	24	32	0	0	0	145	145
23	Indianpoint-ESSFwk1-1	2,126	1,940	404	63	27	26	154	186
24	Indianpoint-SBSwk1-2	9,606	8,667	865	104	40	97	516	1,300
25	Jack-of-Clubs-ESSFwc3-1	6,677	3,593	1,269	316	740	1,197	2,590	3,064
26	Jack-of-Clubs-ESSFwk1-1	10,375	7,001	1,971	215	373	429	1,008	3,376
27	Jack-of-Clubs-SBSwk1-2	1,900	1,297	171	48	31	74	121	603
28	Lightning-ESSFwc3-1	303	148	58	0	0	20	141	155
29	Lightning-ESSFwk1-1	3,116	2,392	592	0	0	101	526	723

LUBEC-NDT & Analysis ID		Productive Area (ha)	THLB Area (ha)	Target Area (ha)	Current Area (ha)	Area Older than Target at Specified Periods			
						20 Years	50 Years	100 Years	250 Years
30	Lightning-SBSmw-3	2,070	1,599	228	533	311	334	367	459
31	Lightning-SBSwk1-2	9,320	7,620	839	0	0	282	607	1,700
32	Swift-ESSFwc3-1	7,143	2,896	1,357	186	657	1,867	2,762	4,244
33	Swift-ESSFwk1-1	11,196	8,749	2,127	228	271	961	1,914	2,444
34	Swift-SBSwk1-2	6,893	5,860	620	37	12	309	533	1,034
35	Umiti-ESSFwc3-1	392	168	75	63	214	234	224	224
36	Umiti-ESSFwk1-1	2,976	2,379	565	38	108	570	998	1,071
37	Umiti-SBSdw1-3	1,619	924	178	161	210	536	771	780
38	Umiti-SBSmh-3	67	0	7	24	24	66	67	67
39	Umiti-SBSmw-3	26,005	20,003	2,861	2,381	2,222	2,552	6,087	7,755
40	Umiti-SBSwk1-2	5,794	4,980	522	0	188	136	407	1,527
41	Victoria-ESSFwc3-1	2,095	1,079	587	338	391	1,031	1,089	1,131
42	Victoria-ESSFwk1-1	6,127	4,151	1,715	229	331	1,122	2,417	3,308
43	Victoria-SBSmw-3	18,566	13,960	2,971	4,574	4,768	6,071	6,027	6,312
44	Victoria-SBSwk1-2	16,878	13,489	2,194	64	178	764	2,997	7,391
45	Willow-ESSFwc3-1	657	284	125	0	0	54	306	374
46	Willow-ESSFwk1-1	5,360	4,183	1,019	102	25	130	881	1,177
47	Willow-SBSmw-3	935	693	103	168	88	132	245	244
48	Willow-SBSwk1-2	11,663	9,613	1,050	56	31	354	1,028	2,063

Most of the LUBEC-NDTs achieve the targets for old forest within 50 to 100 years, although some do not achieve the target. However, with OGMAs in place on the TFL, there is not the requirement to maintain these objectives over the entire 250-year planning horizon.

5.2 Alternative Initial Harvest

Based on the impact of the MPB attack and the loss of merchantable timber that will result, two alternative initial harvest rates have been evaluated:

- One million cubic metres per year for 10 years; and
- Maximum harvest level possible for 10 years.

In both of these scenarios the harvest is focused on pine stands affected by MPB. Only the high priority spruce stands are available for harvest from stands not affected by MPB.

Table 5.5 summarizes the harvest levels developed for these two alternative initial harvest levels with comparison to the Base Case.

Table 5.5 – Alternative initial harvest for Base Case

Simulation Year	Annual Harvest Rate (m^3/year)		
	Base Case	**1 Million Initial**	**Maximize Initial**
5	692,800	1,000,000	1,371,680
10	692,800	1,000,000	1,371,680
15	819,600	808,850	719,700
20	819,600	808,850	719,700
25	819,600	808,850	719,700
30	819,600	808,850	719,700
35	819,600	808,850	719,700
40	819,600	808,850	719,700
45	819,600	808,850	719,700
50	819,600	808,850	719,700
55 - 250	868,550	872,670	878,930
MPB pine non-recoverable losses	2,952,255 (39.5%)	1,157,375 (15.5%)	647,375 (8.7%)

As presented in Table 5.5, there is an opportunity to recover considerable pine volume affected by the MPB attack prior to the expiration of the shelf life. Maximizing the initial harvest rate leaves less than 10% of the pine volume in the forest as a non-recoverable loss. Increasing the harvest over the initial 10 years of the simulation still maintains a mid-term harvest level above the current AAC of 692,800 m^3/year, indicating that there is no falldown in harvest noted in many other land bases affected by MPB. Long-term harvest levels for the alternative initial harvest scenarios are similar, approximately 1% higher than the Base Case.

Figure 5.11 presents the results of the alternative initial harvest rate scenarios in graphic format.

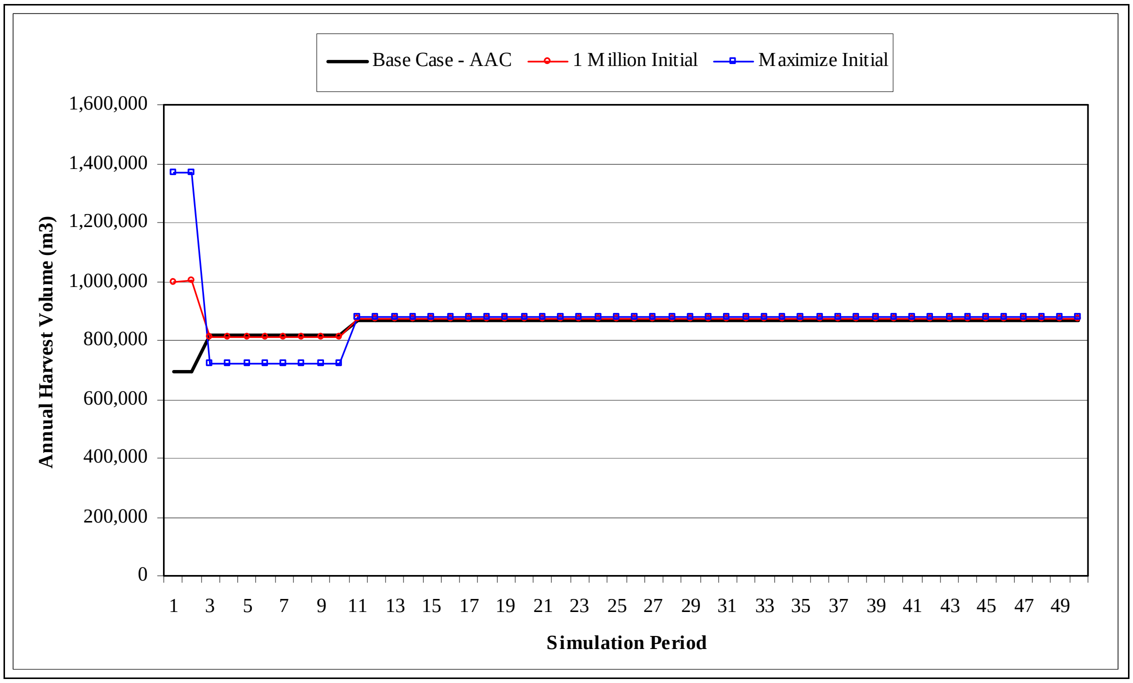

Figure 5.11 – Base Case alternative initial harvest

The elevated initial harvest rate in the Maximize Initial scenario removes additional stands with lower pine content during the first 10 years. This causes the mid-term harvest rate to decline below the levels exhibited by the Base Case and 1-Million Initial scenarios. It is important to note that over the 250-year planning horizon the Maximize Initial scenario is able to harvest 4.9 million cubic metres more than the Base Case, whereas the 1-Million Initial scenario harvests 3.6 million cubic metres more than the Base Case over the same time frame.

The following section summarizes the growing stock results of the 1-Million Initial harvest rate scenario.

5.2.1 1-Million Cubic Metres Initial Harvest Results

The following graphic summaries display the results from the 1-Million Initial harvest scenario. Unlike the Base Case harvest which uses the current AAC, the 1-Million Initial scenario (and Maximize Initial scenario) recover significantly more merchantable volume from the forest without compromising the mid or long-term harvest levels.

Figure 5.12 summarizes the growing stock levels for the 1-Million Initial scenario.

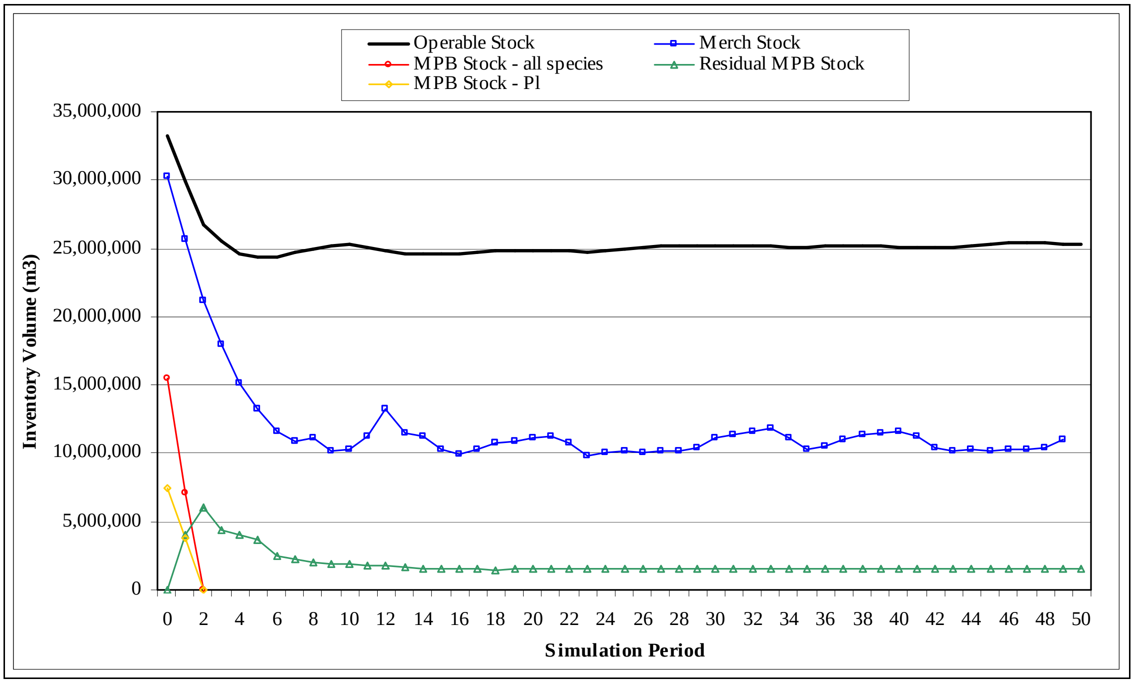

Figure 5.12 – 1-Million Initial growing stock

Similar to the Base Case, the initial declines with the harvest of existing natural stands, mainly affected pine types in the first 10 years. There is a minimal decline below 25 million cubic metres as the natural stand volume is utilized during periods four through six. After this time as second growth managed stand volume accumulates the operable volume is stable for the remainder of the 250-year planning horizon. More pine stands are harvested in the short-term, which then regenerate to a preferred managed stand condition providing additional volume and a more stable timber supply. These managed stands provide more volume in less time compared with the residual natural stands and regenerated natural stands found in the Base Case.

Residual MPB volume, which represents the non-pine species in the low and medium priority groups, is approximately 90% of the Base Case at the end of the 10-year shelf life. This is the result of harvesting additional pine stands affected by MPB. However, this inventory statistic shows that most of the increase in short-term harvest is directed at high priority pine stands.

Figure 5.13 presents the age class distribution for TFL 52 at selected times during the 250-year planning horizon for the 1-Million Initial scenario.

Figure 5.13 – 1-Million Initial age class distributions at selected periods

Compared with the Base Case the key difference in the age class distributions in Figure 5.13 is the spikes of 10 and 20 year old inventory (THLB-Non MPB) at years 10 and 20 respectively. During the remainder of the planning horizon there is an increase in inventory between 70 and 90 years old, which will provide more flexibility in harvesting in the long-term.

Figure 5.14 presents the distribution of the periodic harvest over the planning horizon.

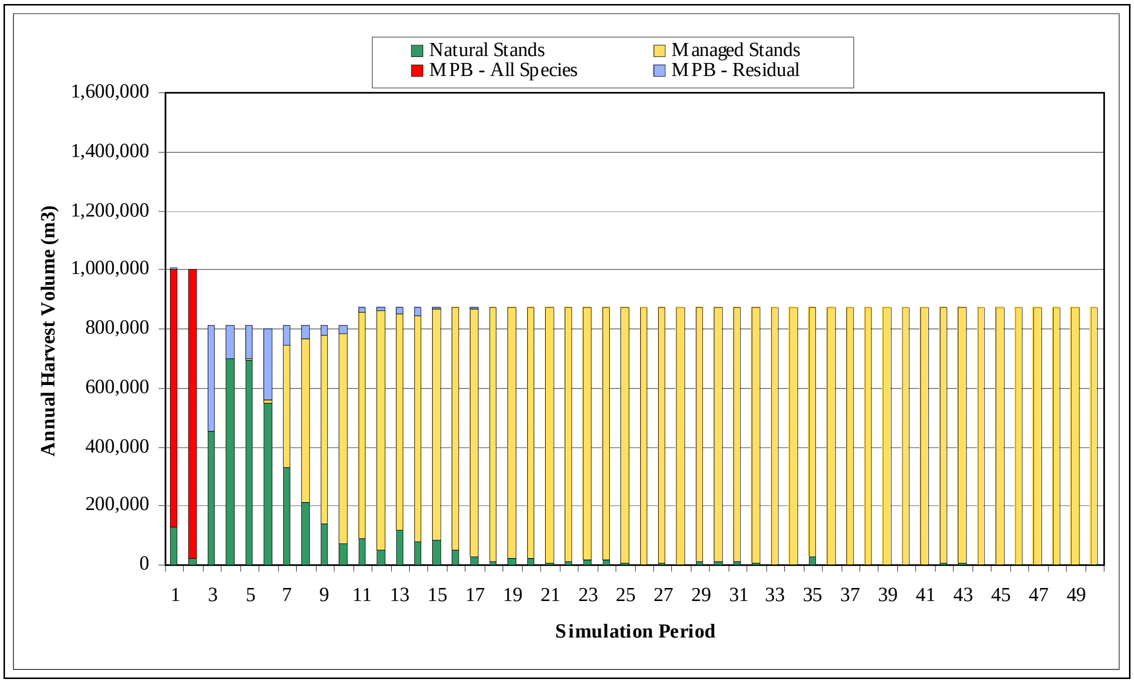

Figure 5.14 – 1-Million Initial harvest distribution by stand type

The increase in harvest during the first 10 years for this scenario is all provided by stands affected by MPB, mainly the high priority types. This leaves residual stands available for harvest during the mid term, maintaining the harvest above 800,000 m^3/year. The high priority stands were harvested and regenerated to managed stands permitting the increase in long-term harvest. Natural stands contribute less volume to the harvest in the long term compared with the Base Case.

Figure 5.15 presents the average harvest area from each block of the TFL and from MPB areas.

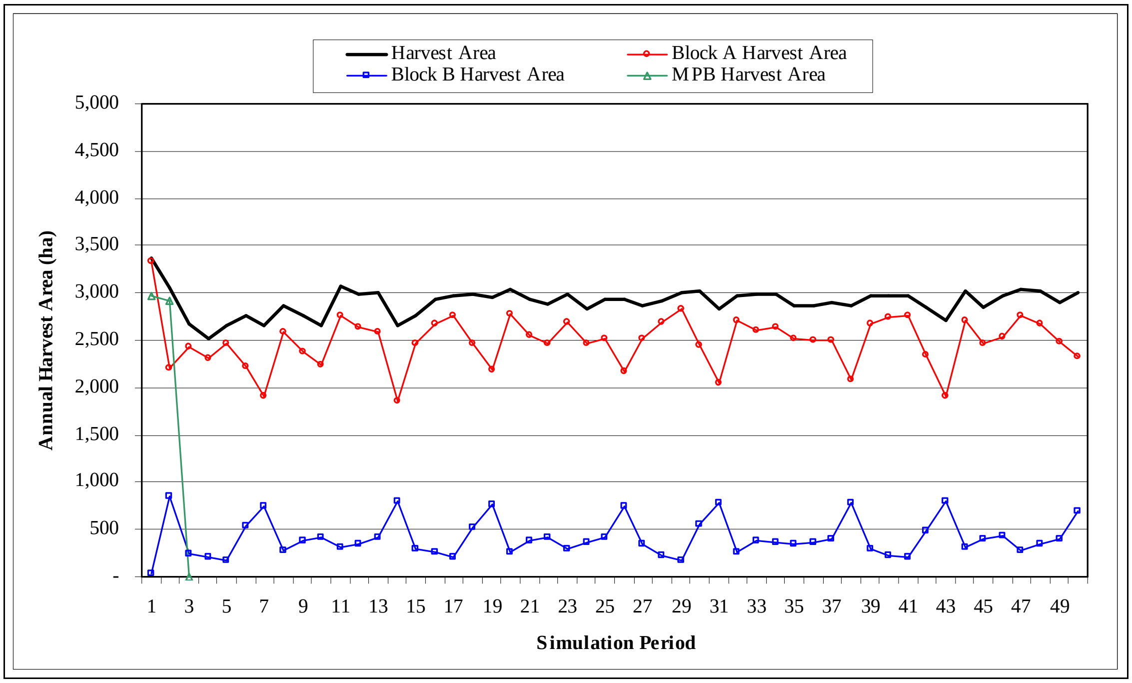

Figure 5.15 – 1-Million Initial harvest area

MPB harvest areas are defined as those areas salvaged during the first 10 years of simulation and therefore become zero in period three and beyond. With significantly more volume harvested during the initial 10 years, there is also more area being harvested. Figure 5.16 shows the average harvest attributes for the 1-Million Initial harvest scenario.

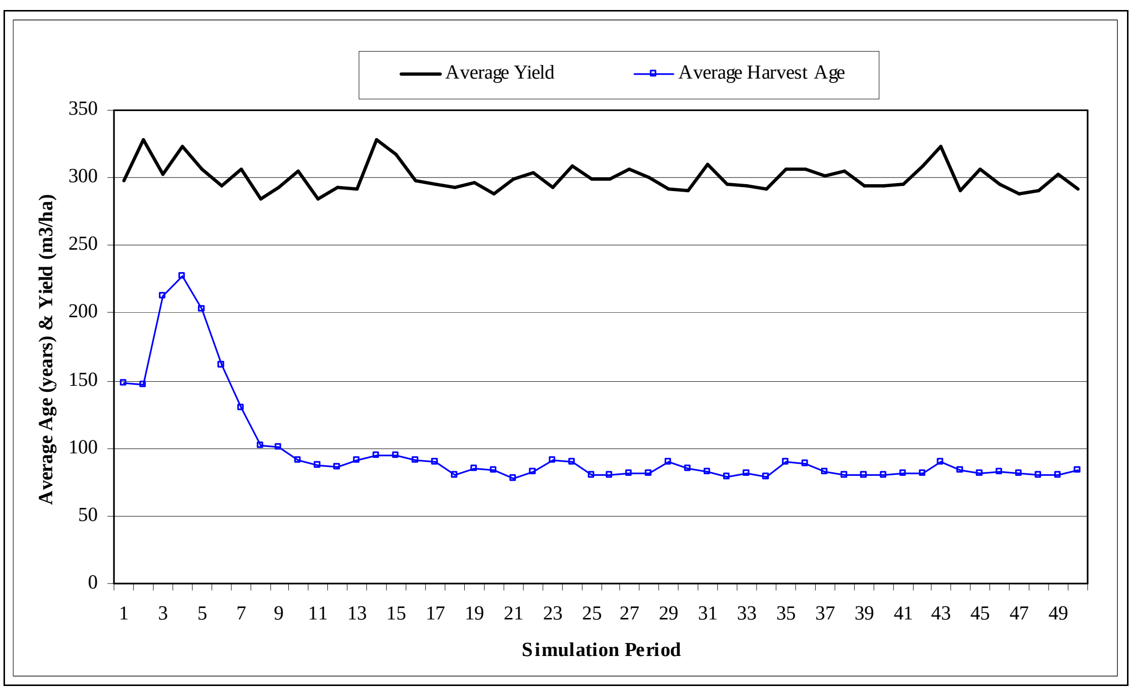

Figure 5.16 – 1-Million Initial average harvest attributes

Average yield fluctuates between 284 m^3/ha and 330 m^3/ha. Variation is less than noted for the Base Case during the mid-term, because more there is a higher component of managed forest with the 1-Million Initial scenario. Over the long term harvest volumes are approximately 300 m^3/ha, with spikes occurring when older, high volume natural stands contribute to the periodic harvest.

5.2.2 Maximize Initial Harvest Results

The following graphic summaries display the results from the Maximize Initial harvest scenario. This harvest level is used for comparing the results of the sensitivity analyses (Section 6) in order to support the request for an uplift in AAC for TFL 52. Unlike the Base Case harvest which uses the current AAC, the Maximize Initial scenario recovers significantly more merchantable volume from the forest without compromising the mid or long-term harvest levels. The Maximize Initial scenario is therefore more suited as the basis for sensitivity analysis.

Figure 5.17 summarizes the growing stock levels for the Maximize Initial scenario.

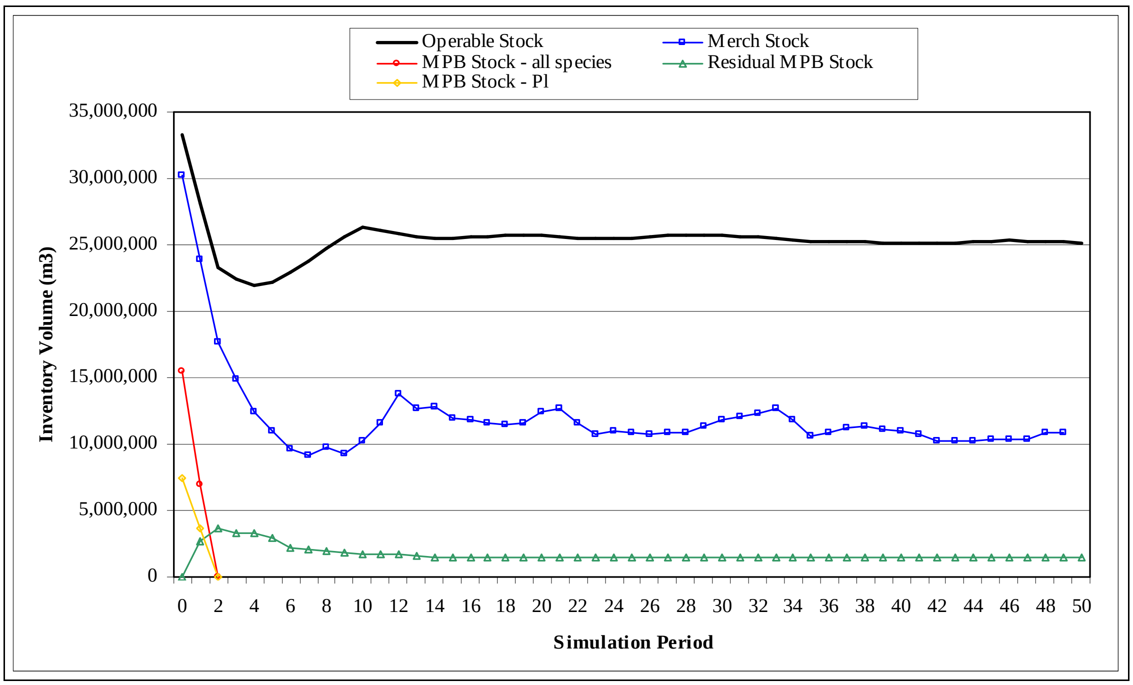

Figure 5.17 – Maximize Initial growing stock

Similar to the Base Case, the initial declines with the harvest of existing natural stands, mainly affected pine types in the first 10 years. After a minor trough in operable volume at period four there is an increase as second growth managed stand volume accumulates. In the Maximize Initial scenario there is more operable volume from year 50 and forward compared to the Base Case. This is the result of more harvesting of pine stands in the short-term, which then regenerate to a preferred managed stand condition. These managed stands provide more volume in less time compared with the residual natural stands and regenerated natural stands found in the Base Case.

Residual MPB volume, which represents the non-pine species in the low and medium priority groups, is only about 3.6 million cubic metres at the end of the 10-year shelf life, or 55% of the amount noted in the Base Case. Increased harvest of the affected pine stands is the reason for the decline in the Maximize Initial scenario.

Figure 5.18 presents the age class distribution for TFL 52 at selected times during the 250-year planning horizon for the Maximize Initial scenario.

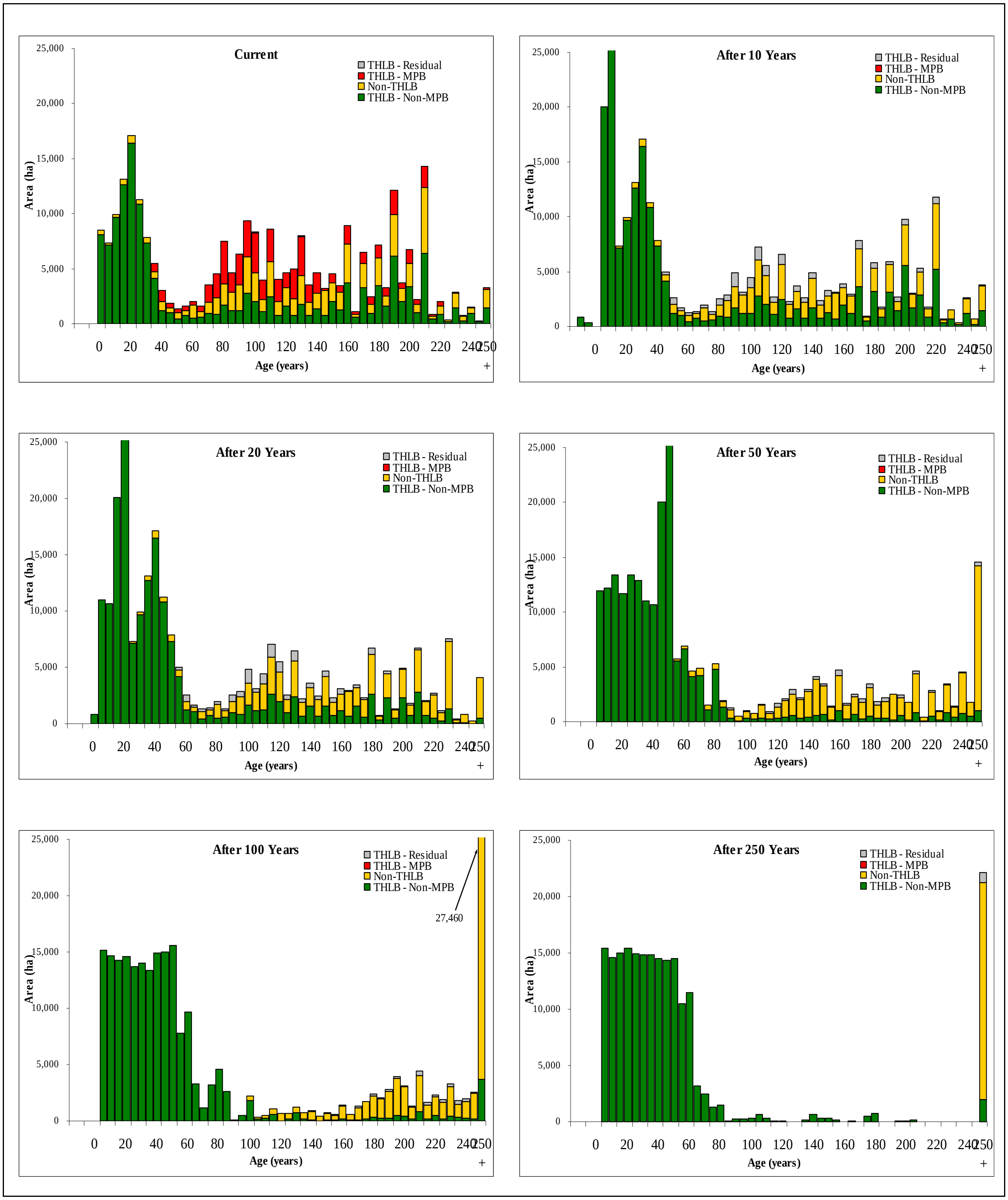

Figure 5.18 – Maximize Initial age class distributions at selected periods

Compared with the Base Case the key difference in the age class distributions in Figure 5.18 is the reduction in THLB-Residual area after 10 years of simulation. The increased harvest of MPB-affected stands in the first 10 years converts these areas into managed THLB-Non MPB types as noted by the spikes of 10 and 20 year old inventory (THLB-Non MPB) at years 10 and 20 respectively. During the remainder of the planning horizon there is an increase in inventory between 70 and 90 years old, which will provide more flexibility in harvesting in the long-term.

Figure 5.19 displays the distribution of the periodic harvest over the planning horizon.

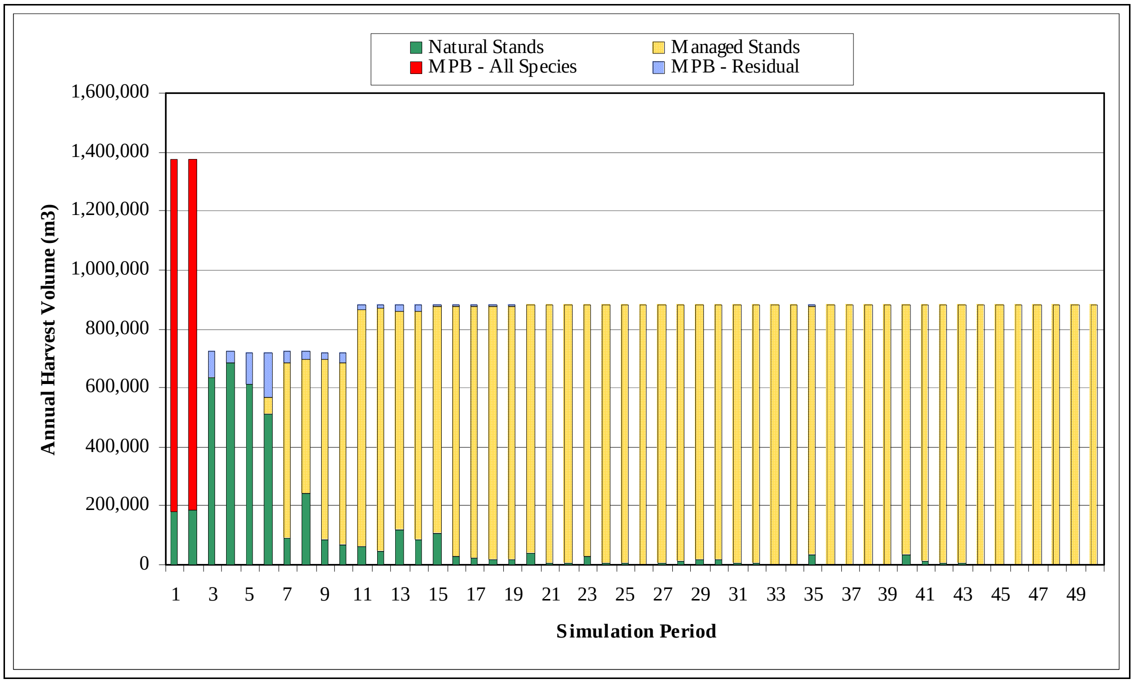

Figure 5.19 – Maximize Initial harvest distribution by stand type

The increase in harvest during the first 10 years for this scenario is all provided by stands affected by MPB. The lack of residual stands, which were converted to young managed stands after harvest, in the mid-term is the reason for the lower mid-term harvest rate in this scenario. However, this provides an increase in available managed stand volume beginning in period seven. Natural stands contribute less volume to the harvest in the long term compared with the Base Case.

Figure 5.20 presents the average harvest area from each block of the TFL and from MPB areas.

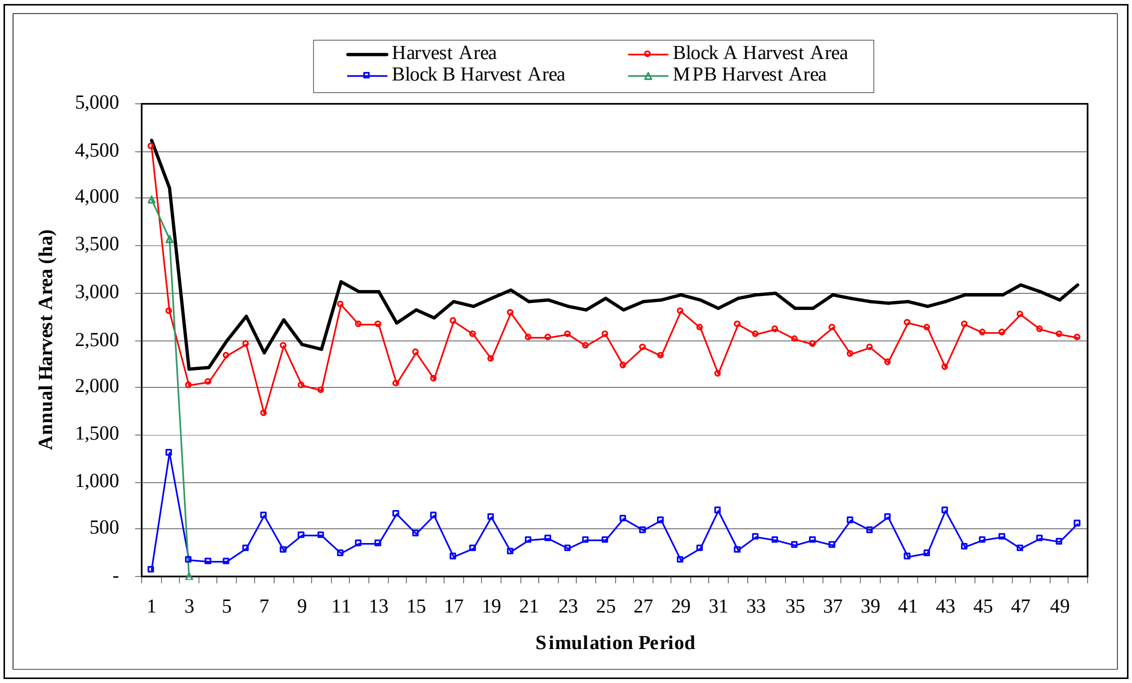

Figure 5.20 – Maximize Initial harvest area

MPB harvest areas are defined as those areas salvaged during the first 10 years of simulation and therefore become zero in period three and beyond. With significantly more volume harvested during the initial 10 years, there is also more area being harvested in the Maximize Initial scenario. Figure 5.21 shows the average harvest attributes for the Maximize Initial scenario.

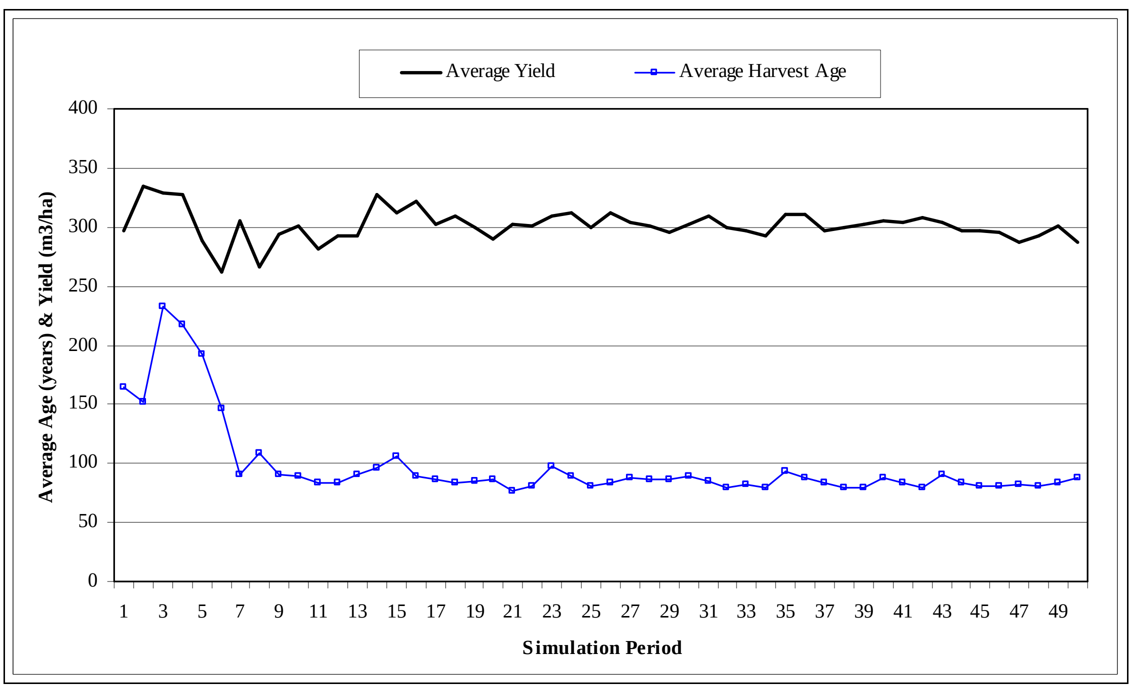

Figure 5.21 – Maximize Initial average harvest attributes

Average yield is highest during the second period (years six through 10) similar to the Base Case. It is at this time that high priority pine stands dominate the harvest profile. However the mid-term harvest yields are lower than noted for the Base Case. Over the long term volumes are approximately 300 m^3/ha.

Harvest age is highest during period three, after all salvage is completed and the residual and other non-pine stands are harvested. These stands were not included in the short-term harvest profile based on management priorities for pine, and were therefore ageing and accumulating additional volume. After managed stands contribute to the annual harvest the average harvest age is typically between 75 and 95 years of age, which is older than the average minimum harvest age for the TFL.

The following section summarizes the sensitivity analyses completed for the analysis. As noted above the sensitivity harvest rate is based on the Maximize Initial harvest level developed for the land base.

6.0 SENSITIVITY ANALYSIS RESULTS

6.1 Shelf Life Estimates

There is uncertainty related to the time stands affected by MPB will remain merchantable. The Base Case assumption is that pine stands on wet sites remain merchantable for five years, and those on moist sites will last for 10 years. In this set of sensitivity analyses the shelf life is set at five and 10 years for all stands regardless of moisture status. Table 6.1 summarizes the harvest levels developed for these two sensitivity analyses with comparison to the Maximize Initial and Base Case scenarios.

Table 6.1 – Alternative shelf life annual harvest

Simulation Year	Annual Harvest Rate (m^3/year)			
	Base Case	Maximize Initial	All Stands 5-Year Shelf Life	All Stands 10-Year Shelf Life
5	692,800	1,371,680	2,048,950	1,374,860
10	692,800	1,371,680	710,190	1,374,860
15	819,600	719,700	710,190	722,990
20	819,600	719,700	710,190	722,990
25	819,600	719,700	710,190	722,990
30	819,600	719,700	710,190	722,990
35	819,600	719,700	710,190	722,990
40	819,600	719,700	710,190	722,990
45	819,600	719,700	710,190	722,990
50	819,600	719,700	710,190	722,990
55 - 250	868,550	878,930	880,380	878,860
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	1,182,270 (15.8%)	473,190 (6.3%)

Reducing shelf life to five years for all stands forces a dramatic increase in the short-term harvest level, which is likely not feasible operationally. Extending shelf life to 10 years has virtually no impact on the harvest schedule compared to the Maximize Initial scenario. This indicates that the model has been able to select the stands for harvest during the appropriate period in prior to expiration of the shelf life in the Maximize Initial scenario. Minor increases are the result of slightly more flexibility in choosing harvest candidates. Long-term harvest levels are similar for all the shelf life sensitivity analyses.

Figure 6.1 presents the results of the shelf life sensitivity analyses in graphic format.

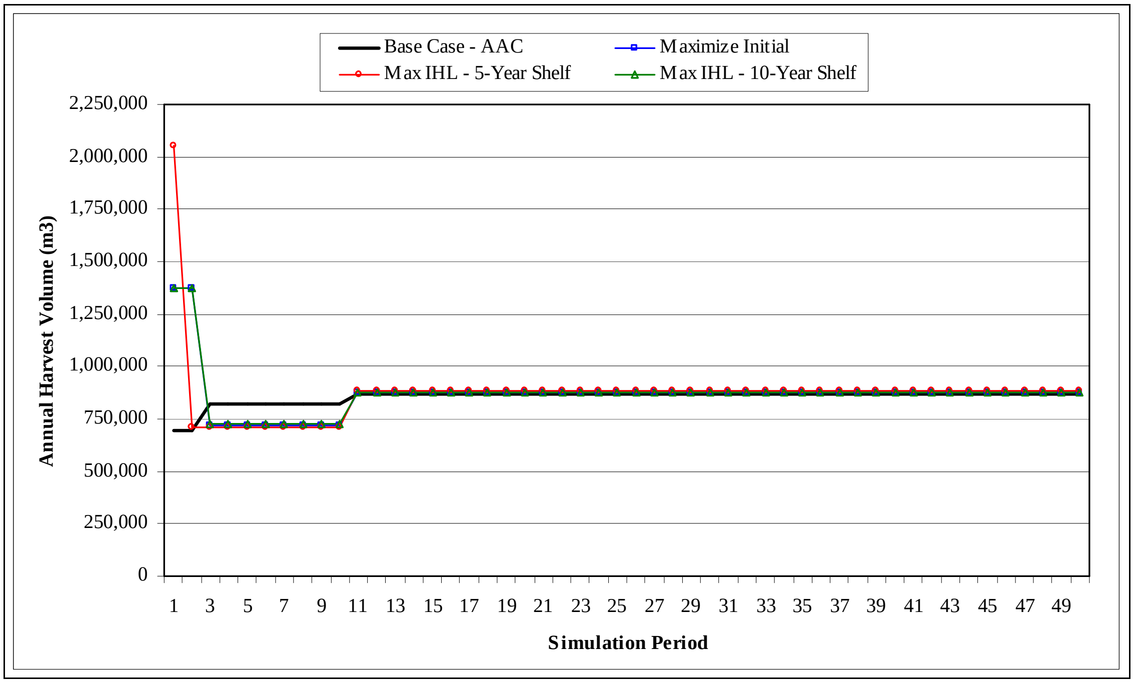

Figure 6.1 – Shelf life sensitivity annual harvest

6.2 Regeneration Delay and Rehabilitation on Unsalvaged Areas

The Base Case assumes that high volume pine stands (> 50% pine) not salvaged prior to expiration of the shelf life revert to a natural stand with no residual volume. A regeneration delay of 15 years is also assigned to these stands. In these sensitivity analyses 10 and 20-year regeneration delays replace the Base Case assumption.

In addition, sensitivity analysis was completed in which unsalvaged areas were immediately converted to managed stands with the associated improvements in volume and rotation age. Table 6.2 summarizes the harvest levels developed for these two sensitivity analyses with comparison to the Maximize Initial and Base Case scenarios.

Table 6.2 – Alternative regeneration delay and rehabilitation annual harvest

Simulation Year	Annual Harvest Rate (m^3/year)				
	Base Case	Maximize Initial	Rehab All High Volume Pine	10-Year Regeneration Delay	20-Year Regeneration Delay
5	692,800	1,371,680	1,352,260	1,369,460	1,372,730
10	692,800	1,371,680	1,352,260	1,369,460	1,372,730
15	819,600	719,700	727,000	720,550	719,220
20	819,600	719,700	727,000	720,550	719,220
25	819,600	719,700	727,000	720,550	719,220
30	819,600	719,700	727,000	720,550	719,220
35	819,600	719,700	727,000	720,550	719,220
40	819,600	719,700	727,000	720,550	719,220
45	819,600	719,700	727,000	720,550	719,220
50	819,600	719,700	727,000	720,550	719,220
55 - 250	868,550	878,930	879,790	879,000	878,810
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	677,120 (9.1%)	662,590 (8.9%)	654,090 (8.8%)

Rehabilitating high volume pine sites that were not salvaged in order to place them in a managed condition has a modest impact on the short-term harvest. The initial harvest rate is 1.5% lower than the Maximize Initial, and the mid-term is approximately 1% higher. Some high volume pine areas that were harvested in the Maximize Initial scenario are substituted with medium and low volume stands in this sensitivity. The trade-offs are subtle, with the model comparing existing volume and the potential regeneration volume. Therefore some managed stands are created as the result of rehabilitation on what were sites with high pine content with an associated increase in harvest of medium or low content pine stands.

Modifying regeneration delay on unsalvaged areas makes no difference to the Maximize Initial harvest schedule. This is because most of the high volume pine stands are harvested prior to them being rendered unmerchantable. The optimization model attempts to harvest these sites because of the potential losses that will be experienced if they are left unsalvaged.

Figure 6.2 displays the results of the rehabilitation and regeneration delay sensitivity analyses in graphic format.

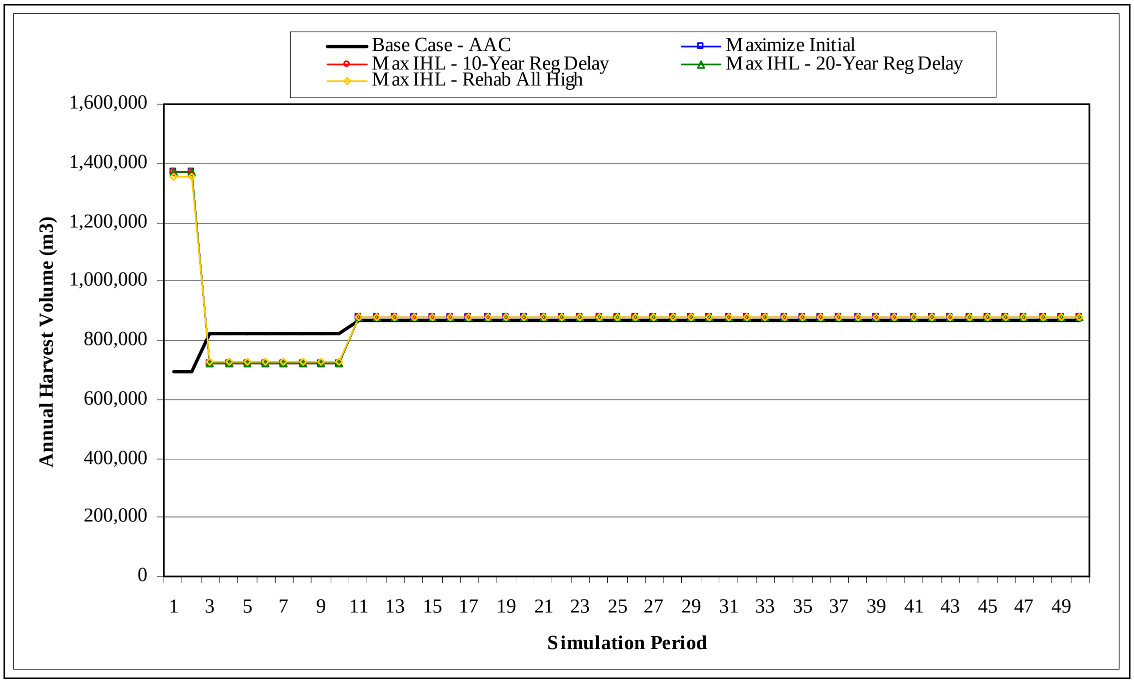

Figure 6.2 – Regeneration delay sensitivity annual harvest

6.3 Post-Attack Yields for MPB Sites

In this set of analyses the yields for residual stands after the shelf life has expired is modified. In the Base Case scenarios post attack yields were based on a formula described in the Information Package which reduces the volume based on pre-attack pine content and level of attack. In these sensitivities two alternate post-attack volume levels are modelled:

- 100% of pre-attack pine volume is lost; and
- 50% of pre-attack pine volume is lost.

Also in this section the genetic gains for managed stand yields for Block A are increased to match those modelled for Block B. Both areas of the TFL use improved seed from the same orchard and therefore it is expected the yields will be similar.

Table 6.3 summarizes the results of these analysis scenarios.

Table 6.3 – Alternative post-attack and managed stand yields annual harvest

Simulation Year	Annual Harvest Rate (m³/year)				
	Base Case	**Maximize Initial**	**Block B Genetic Gains**	**100% Pine Mortality**	**50% Pine Mortality**
5	692,800	1,371,680	1,343,320	1,368,510	1,367,600
10	692,800	1,371,680	1,343,320	1,368,510	1,367,600
15	819,600	719,700	736,320	720,140	725,740
20	819,600	719,700	736,320	720,140	725,740
25	819,600	719,700	736,320	720,140	725,740
30	819,600	719,700	736,320	720,140	725,740
35	819,600	719,700	736,320	720,140	725,740
40	819,600	719,700	736,320	720,140	725,740
45	819,600	719,700	736,320	720,140	725,740
50	819,600	719,700	736,320	720,140	725,740
55 - 250	868,550	878,930	919,220	878,890	878,820
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	671,900 (9.0%)	657,150 (8.8%)	759,060 (10.2%)

Including Block B genetic gains causes an initial reduction in the harvest rate, but this is combined with increases of 2% and 5% in the mid and long term, respectively compared with the Maximize Initial harvest schedule. Gains for spruce are 10% higher in this scenario which provides the majority of the increase. Minimal Douglas-fir occupies Block A so gains for that species, although significant, do not influence the harvest level.

Changing the mortality levels for pine in attacked stands does not alter the harvest level significantly. Reducing the impact to 50% allows the mid-term harvest to increase by only 1%. This indicates that the majority of harvest in attacked stands focuses on those with higher pine content. Therefore the adjusted residual volume affects stands with a minor component of pine so the impact is reduced.

Figure 6.3 displays the results of the modified yields post-attack and Block B genetic gains sensitivity analyses in graphic format.

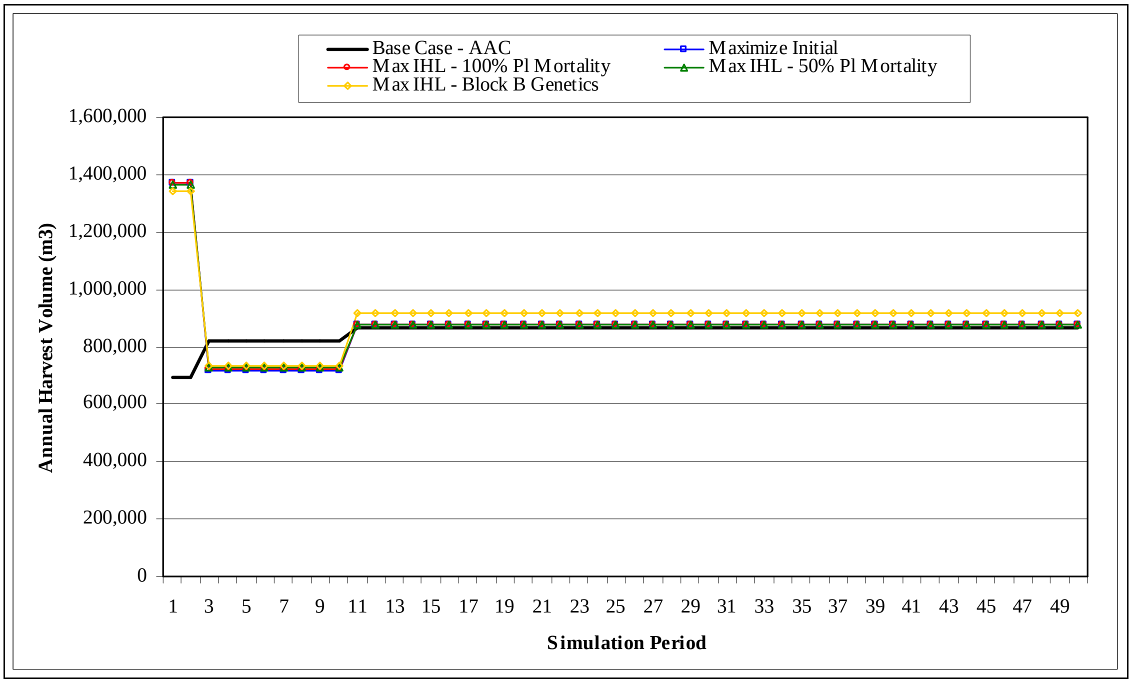

Figure 6.3 – Post-attack and managed stand yields sensitivity annual harvest

6.4 Modify Short-Term Non-Pine Harvest

The Base Case models 140,000 m^3/year of high priority spruce stands (> 65% spruce) for the first five years of simulation. This is to address spruce beetle issues on the TFL. Other than these stands a minimum, less than 5% of the annual harvest, is from non-pine stands during the first five years. Two sensitivity analyses were completed in which the harvest of non-pine stands was modified during the first five years of simulation:

- Increase to 350,000 m^3/year, representing approximately 50% of the current AAC; and
- Reduce non-pine harvest to less than 25,000 m^3/year.

Non-pine harvest may include high priority spruce stands but there was no specified target for these stands in these sensitivity analyses. Table 6.4 summarizes the results of these analysis scenarios.

Table 6.4 – Modify short-term non-pine annual harvest

Simulation Year	Annual Harvest Rate (m^3/year)			
	Base Case	Maximize Initial	Increase Short-term Non-Pine Harvest	Maximum 5% Short-term Non-Pine Harvest
5	692,800	1,371,680	1,398,640	1,374,860
10	692,800	1,371,680	1,398,640	1,374,860
15	819,600	719,700	709,890	722,990
20	819,600	719,700	709,890	722,990
25	819,600	719,700	709,890	722,990
30	819,600	719,700	709,890	722,990
35	819,600	719,700	709,890	722,990
40	819,600	719,700	709,890	722,990
45	819,600	719,700	709,890	722,990
50	819,600	719,700	709,890	722,990
55 - 250	868,550	878,930	879,160	878,860
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	909,430 (12.2%)	473,190 (6.3%)

Increasing the non-pine harvest in the short-term allows a minor 2% increase in the initial harvest rate. However, the mid-term is reduced by almost the same amount and this reduction is maintained for 40 years. Non-pine volume supports the harvest after 10 years of simulation, therefore it is expected that an increase in the initial harvest of these species will negatively impact the mid-term harvest, when pine is no longer available. Long-term harvest is not affected by this change to the analysis inputs.

Overall harvest levels are not affected when the non-pine harvest is limited during the initial five years of simulation, with all three phases of the harvest schedule changing by less than 0.5%. The important aspect of this sensitivity is the additional recovery of dead pine volume, approximately 174,000 cubic metres, as pine harvest replaces the spruce and other species during the first period.

Figure 6.4 displays the results of this sensitivity analysis in graphic format.

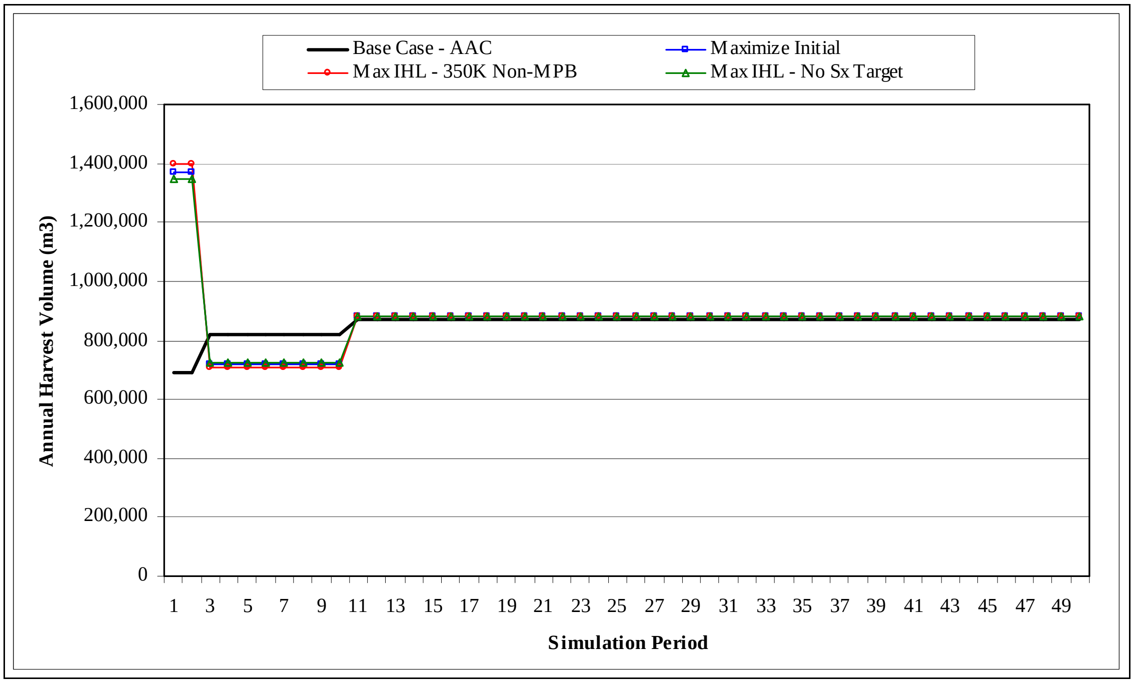

Figure 6.4 – Modify short-term non-pine harvest sensitivity annual harvest

6.5 THLB Adjustments

In this set of analyses the THLB is increased and decreased by 5% to simulate unexpected changes to the land available for long-term harvest. In addition, results of the scenario in which removal of the caribou no-harvest area being considered by the Species at Risk Coordination Office (SaRCO) is also summarized.

Table 6.5 summarizes the results of these analysis scenarios.

Table 6.5 – THLB adjustments annual harvest

Simulation Year	Annual Harvest Rate (m³/year)				
	Base Case	Maximize Initial	Exclude SaRCO Caribou No-harvest	THLB +5%	THLB -5%
5	692,800	1,371,680	1,229,922	1,429,170	1,401,500
10	692,800	1,371,680	1,229,922	1,429,170	1,401,500
15	819,600	719,700	706,800	731,140	671,590
20	819,600	719,700	706,800	731,140	671,590
25	819,600	719,700	706,800	731,140	671,590
30	819,600	719,700	706,800	731,140	671,590
35	819,600	719,700	706,800	731,140	671,590
40	819,600	719,700	706,800	731,140	671,590
45	819,600	719,700	706,800	731,140	671,590
50	819,600	719,700	706,800	731,140	671,590
55 - 250	868,550	878,930	854,730	902,120	840,000
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	708,220 (9.5%)	699,670 (9.3%)	525,260 (7.0%)

Excluding the no-harvest caribou areas being considered by SaRCO reduces the THLB by approximately 13,870 ha (7%) from the THLB. Most of this area includes non-pine stands so the impact of harvest requirements for MPB-attacked areas is not changed. The initial harvest level is reduced by 10%, while the mid and long-term harvest levels are lowered by 2% and 3% respectively. Many of these areas were previously limited for harvest due to other caribou and seral constraints; therefore the impact is not the full 7% of the land base reduction.

Increasing the THLB by 5% allows the harvest to increase over the entire planning horizon. Initially there is a 4% increase in the annual harvest, followed by 2% and 3% increases in the mid and long-term respectively.

Reducing the THLB by 5% also permits a short-term harvest increase of 3%. The model is attempting to remove as much of the damaged pine in the short term prior to the loss of volume and forest cover constraints limiting access during the mid and long term. Mid-term harvest is 7% below that of the Maximize Initial scenario, while the long-term harvest is 4% lower. This is the only sensitivity analysis in which the mid-term harvest level falls below the current AAC for the licence.

Figure 6.5 presents the results of the land base sensitivity analyses in graphic format.

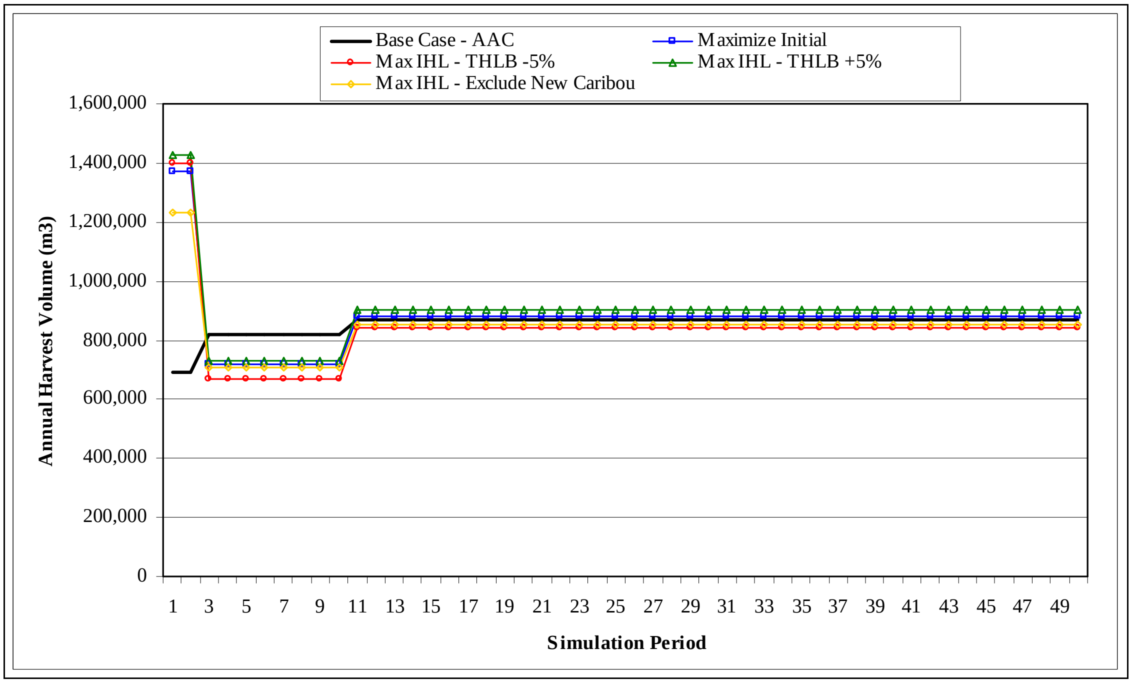

Figure 6.5 – Land base adjustment sensitivity annual harvest

6.6 Forest Cover Constraints

In this set of analyses the forest cover constraints modelled in the Base Case scenarios are modified. IRM and VQO disturbance requirements are not included for the first 15 years of simulation. This will show if more harvesting flexibility is gained, allowing more salvage of MPB damaged timber. The constraint is removed for 15 years – 10 of salvage and an additional five to allow areas to green-up and recover from increased salvage harvesting.

Old seral constraints are not modelled in the Base Case because OGMAs have been identified on TFL 52. A sensitivity has been completed in which the old forest requirements are enforced to evaluate the impact on timber supply.

Table 6.6 summarizes the results of these analysis scenarios.

Table 6.6 – Forest cover constraints adjustments annual harvest

Simulation Year	Annual Harvest Rate (m^3/year)			
	Base Case	Maximize Initial	No IRM or VQO Disturbance for 15 Years	Enforce LUBEC-NDT Old Seral
5	692,800	1,371,680	1,394,610	1,039,790
10	692,800	1,371,680	1,394,610	1,039,790
15	819,600	719,700	715,490	709,370
20	819,600	719,700	715,490	709,370
25	819,600	719,700	715,490	709,370
30	819,600	719,700	715,490	709,370
35	819,600	719,700	715,490	709,370
40	819,600	719,700	715,490	709,370
45	819,600	719,700	715,490	709,370
50	819,600	719,700	715,490	709,370
55 - 250	868,550	878,930	879,060	877,740
MPB pine non-recoverable losses	2,952,250 (39.5%)	647,370 (8.7%)	631,430 (8.5%)	1,085,430 (14.5%)

Removing IRM and VQO disturbance constraints in the short-term permits a 2% increase in harvest during the initial 10 years of simulation. However, there is a minor (less than 1%) decline in the mid-term harvest caused by additional volume being harvested during the first 10 years. Long-term harvest is not affected by this change to modelling inputs.

Including old seral constraints has an immediate impact on the harvest rate. The short-term level drops by 24% as the oldest stands are retained to meet old forest objectives. Mid-term harvest level is reduced by 1% and the long-term is not affected.

Figure 6.6 presents the results of the land base sensitivity analyses in graphic format.

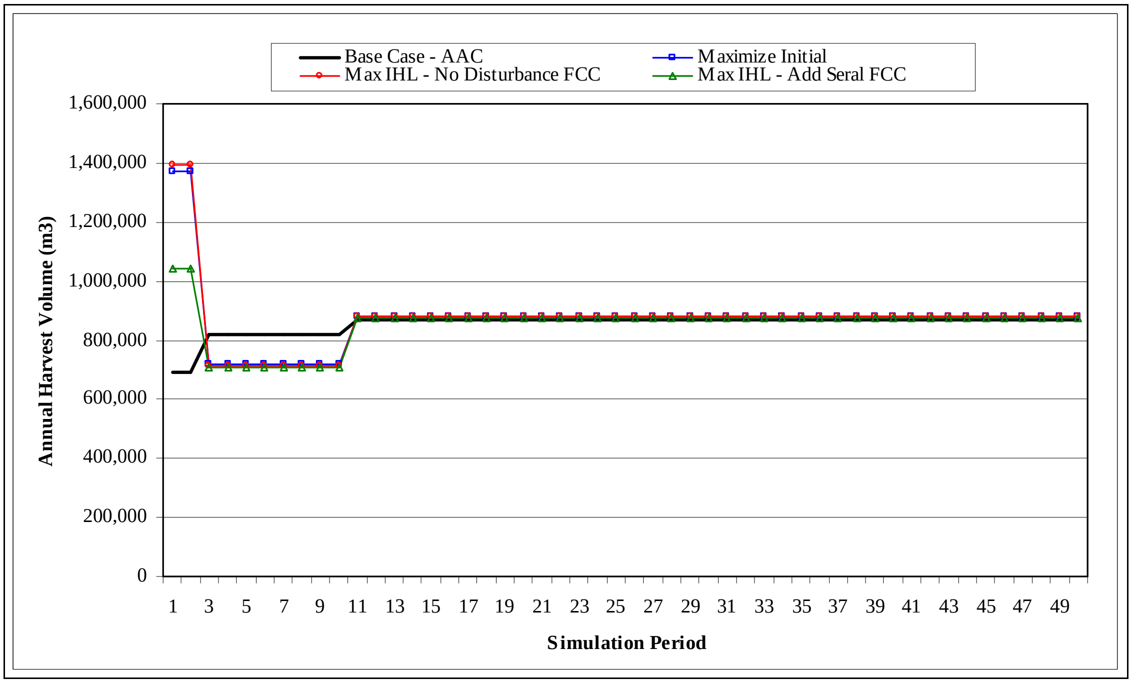

Figure 6.6 – Forest cover constraints adjustment sensitivity annual harvest

7.0 DISCUSSION AND CONCLUSION

The timber supply analysis for TFL 52 has reviewed impacts of the MPB attack on existing pine stands and future harvest potential from the land base. A number of key elements are included in this analysis compared with previous studies done for the TFL including:

- Block B, formerly TFL 5, is now part of TFL 52, which increases the THLB by approximately 27,700 ha;
- OGMAs have been identified on the TFL which removes the old forest constraint from timber supply modelling;
- Assumptions for pine stands affected by MPB, including shelf life and residual volume in mixed stands; and
- Other non-timber interests such as conservation legacy areas and updated caribou mapping.

The analysis included updated inventory (VRI) dated and current assumptions for productive areas not available for long-term timber supply (netdowns). Yields were based on the previous management plan analyses for each block of the TFL.

The harvest schedule for all scenarios and sensitivity analyses has three distinct phases:

- Short-term, the initial 10 years during which salvage of merchantable pine is possible;
- Mid-term, years 11 to 50 when remaining natural stands and residual mixed species stands contribute to the harvest. After year 31 managed stands contribute to the annual harvest; and
- Long-term, years 51 to 250, with managed stands providing the majority of the annual harvest and the age class distribution becomes more evenly distributed.

Evaluating the timber supply and harvest flow in Woodstock, these transition points remained consistent for the various scenarios and sensitivity analyses completed.

Results indicate that it is possible to capture a large component of the dead and dying pine timber on the TFL prior to expiration of the shelf life. Setting the initial harvest at the current AAC of 692,800 m^3/year in one scenario of the Base Case recovers only 60% of the pine volume impacted by MPB, leaving over 2.95 million cubic metres unsalvaged. Increasing the initial annual harvest rate to 1.372 million cubic metres allows maximum salvage of affected pine improves recovery to over 90% with less than 650,000 cubic metres left unsalvaged.

Increasing the initial harvest rate to maximize the recovery of damaged pine timber reduces the mid-term harvest by approximately 100,000 cubic metres annually. However, the mid-term harvest is 4% higher than the current AAC for the Licence, and the overall harvest during the 250 year planning horizon is 2% higher than the Base Case scenario which used the current AAC as the initial harvest rate. The long-term harvest level is marginally higher when pine salvage is maximized due to more stands being converted to managed stands rather than being left as residual or natural regeneration.

TFL 52 has, on average, less pine content compared with the surrounding Quesnel TSA and this benefits the TFL timber supply in two ways:

- It is possible to recover a large component of the damaged pine volume from stands with moderate to high pine content; and
- There is reasonable volume of non-pine volume remaining in the mixed species stands that are not harvested during the 10 year shelf life period.

This second aspect of the inventory is important for maintaining the harvest level above the current AAC during the period 11 to 30 years into the future prior to managed stands becoming available for harvest in year 31. The average pine content of the “low” pine stands is approximately 17%, which leaves many mixed species stands with upwards of 250 m^3/ha of residual merchantable volume after the expiration of the 10 year shelf life.

Sensitivity analysis indicates that many factors included in the analysis do not have a significant impact on the timber supply. Assumptions for shelf life and residual stand volume are especially important because they affect the time that will be available to recover damaged timber, or in cases where salvage is not possible, what volume remains in the stand.

Reducing shelf life for all sites to five years increases the initial harvest rate to over 2 million cubic metres per year, a level which is unlikely to be achieved operationally. Mid and long-term levels are only marginally different from the Maximize Initial harvest schedule. Extending shelf life to 10 years does not influence the harvest rate during any phases.

Similarly adjusting the regeneration delay, or increasing the rehabilitation on unsalvaged stands does not impact the Maximize Initial harvest schedule. This is mainly due to the fact that in the Maximize Initial scenario most of the sites with high pine content are salvaged as a priority before the shelf life expires so there are limited areas that will be affected by these changes.

Reducing the mortality of pine in mixed species stands allows a minor increase in the mid-term harvest level, but there is no change to the long-term level. Increasing the mortality of pine stands compared to the Base Case levels has no impact on the harvest rate.

Assigning the Block B genetic gains to Block A allows the harvest to increase by 2% and 5% in the mid and long-term, respectively. This is due to a 10% increase in spruce yields for managed stands planted with improved seed.

Changes to the THLB influence the harvest level, mainly in the mid and long term. A 5% increase in the THLB allows the harvest to increase between 2% and 4% across the planning horizon. Conversely reducing the THLB by 5% reduces the annual harvest by 7% and 4% in the mid and long-term, respectively. Excluding the on-harvest caribou habitat areas being considered by SaRCO causes the short-term harvest to decline by 10%, followed by approximately 3% reductions for the rest of the planning horizon.

Removing the disturbance limits in IRM and VQO areas during the years when pine salvage occurs allows a minor 2% increase in short-term harvest. This is followed by a minimal decline in mid-term harvest, and no change to the long-term level compared to the Maximize Initial harvest schedule. Enforcing the old seral constraints at the LUBEC-NDT level results in an immediate 10% drop in initial harvest rate, followed by a 1% reduction in the mid-term level. Many areas are in deficit for old forest and therefore many areas must be put into temporary reserve which limits access during the first 10 years of simulation. However with the establishment of OGMAs there does not appear to be a need to include these old seral constraints.

7.1 Conclusions

The analysis for TFL 52 indicates that a considerable salvage opportunity exists on the licence and that more than 90% of the dead or dying pine volume can be salvaged if the harvest is increased over the next 10 years. If left at the current AAC only 60% of the damaged timber will be recovered. The mid-term harvest is maintained at a level above the current AAC with either level of harvest in the short term. Long-term harvest levels are indicated to increase to approximately 878,000 m^3/year after 50 years.

These harvest levels are possible with all considerations for non-timber resources in place, including riparian, wildlife habitat, visual sensitivity, conservation legacy areas, and mature and old forest requirements.

Sensitivity analysis indicates that the short-term harvest is only affected by large reductions in the THLB or addition of redundant old seral constraints.

It will be important to improve understanding of shelf life estimates and residual volume in mixed species stands to ensure that the harvest is directed to those sites that will provide the best timber supply in the mid-term, while maximizing salvage during the period when pine volume remains merchantable.

8.0 REFERENCES

B.C. Ministry of Forests. 1994. *Cariboo-Chilcotin Land Use Plan.*

B.C. Ministry of Forests. 1999. Cariboo-Chilcotin Land Use Plan – Integration Report.

B.C. Ministry of Forests and Range, Quesnel Forest District. 2006. Quesnel Forest District Enhanced Retention Strategy for Large Scale Salvage of Mountain Pine Beetle Impacted Stands.

J.S. Thrower & Associates Ltd. 2000. *Updating Potential Site Index Estimates for Commercial Tree Species on TFL 5*. Contract report for Weldwood of Canada Ltd. March 31, 2000. 10 pp.

J.S. Thrower & Associates Ltd. 2000. *Potential Site Index Estimates for Major Commercial Tree Species on TFL 52*. Contract report for West Fraser Mills Ltd. March 15, 2000. 20 pp.

J.S. Thrower & Associates Ltd. 2000. *Yield Table Summary Report, West Fraser Mills TFL 52 Quesnel*. Contract report for West Fraser Mills Ltd. May 4, 2000. 35 pp.

J.S. Thrower & Associates Ltd. 2002. *Yield Tables for Natural and Managed Stands: Management Plan 10 on TFL 5*. Contract report for Weldwood of Canada Ltd. February 6, 2002. 32 pp.

J.S. Thrower & Associates Ltd. 2006. *Development of Volume Recovery Model for MPB-Attacked Stands on TFL 52*. Contract report for West Fraser Mills Ltd. May 2, 2006. 7 pp.

Timberline Forest Inventory Consultants Ltd. 2000. *Bowron-Cottonwood Tree Farm Licence (TFL 52) Management Plan 3 Timber Supply Analysis Information Package*. Contract report for West Fraser Mills Ltd. December 20, 2000. 53 pp.

Timberline Forest Inventory Consultants Ltd. 2001. *Bowron-Cottonwood Tree Farm Licence (TFL 52) Management Plan 3 Timber Supply Analysis*. Contract report for West Fraser Mills Ltd. July 12, 2001. 30 pp.

Timberline Forest Inventory Consultants Ltd. 2002. *MacKenzie-Cariboo Tree Farm Licence (TFL 5) Management Plan 10 Timber Supply Analysi Information Package*. Contract report for Weldwood of Canada Ltd. October 16, 2002. 49 pp.

Timberline Forest Inventory Consultants Ltd. 2002. *MacKenzie-Cariboo Tree Farm Licence (TFL 5) Management Plan 10 Timber Supply Analysis*. Contract report for Weldwood of Canada Ltd. October 18, 2002. 30 pp.

APPENDIX I

Timber Supply Analysis Information Package
Management Plan 4
Mountain Pine Beetle Uplift

Bowron-Cottonwood Tree Farm Licence
(TFL 52 Blocks A & B)

(under separate cover)

West Fraser Timber Co. Ltd

Timberline
Natural Resource Group